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STEAM GENERATION
POWER GENERATION
WATER POWER
DIESEL & GAS ENGINES
AIR CONDITIONING & HEATING
REFRIGERATION
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# POWER

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## SEPTEMBER, 1940

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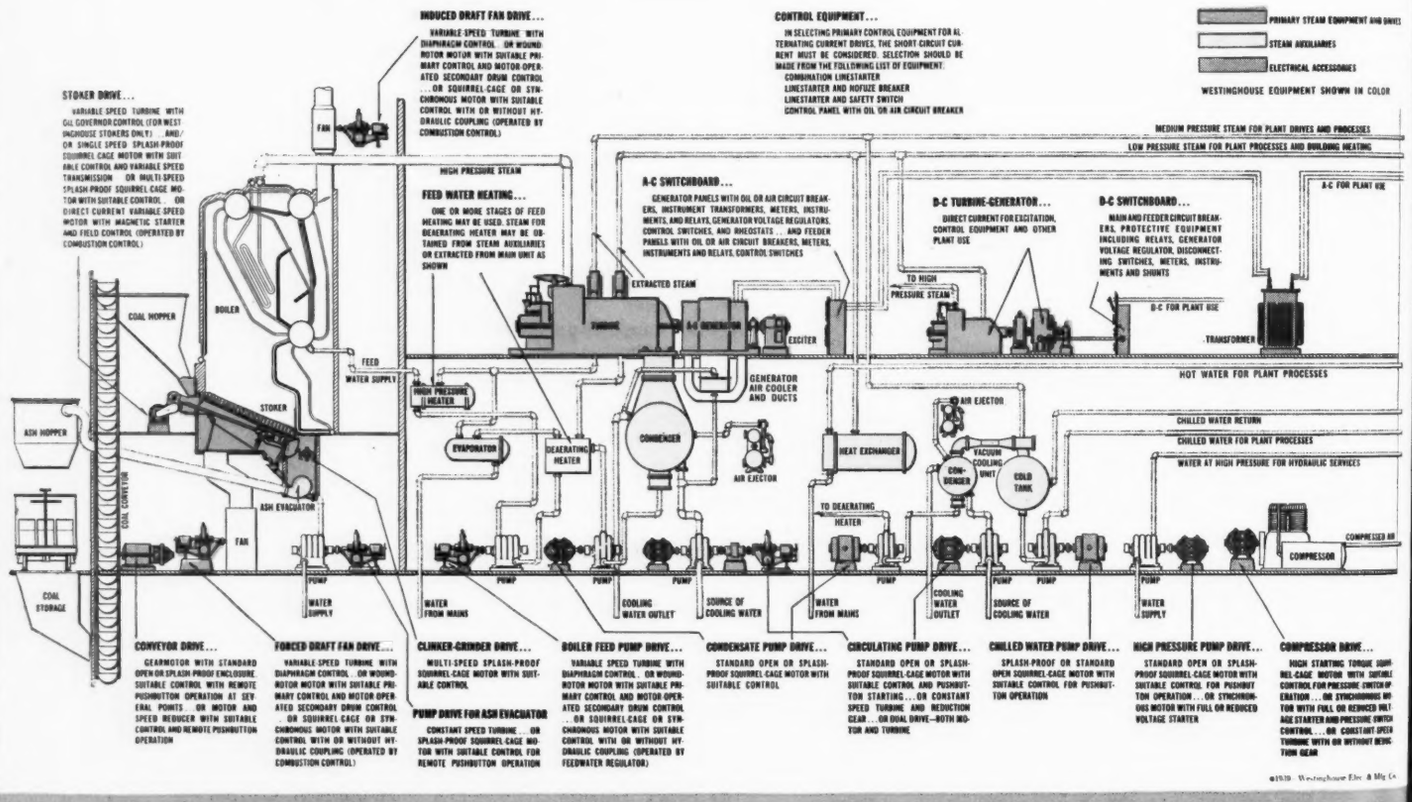
## WESTINGHOUSE POWER PLANT EQUIPMENT


INDUCED DRAFT FAN DRIVE...
VARIABLE-SPEED TURBINE WITH DIAPHRAGM CONTROL OR WOUND-MOTOR MOTOR WITH SUITABLE PRIMARY CONTROL AND MOTOR-OPERATED SECONDARY DRUM CONTROL ...OR SQUIRREL CAGE OR SYNCHRONOUS MOTOR WITH SUITABLE CONTROL WITH OR WITHOUT HYDRAULIC COUPLING (OPERATED BY COMBUSTION CONTROL)
CONTROL EQUIPMENT...
IN SELECTING PRIMARY CONTROL EQUIPMENT FOR ALTERNATING CURRENT DRIVES, THE SHORT-CIRCUIT CURRENT MUST BE CONSIDERED. SELECTION SHOULD BE MADE FROM THE FOLLOWING LIST OF EQUIPMENT:
COMBINATION LINESTARTER
LINESTARTER AND NOFUZE BREAKER
LINESTARTER AND SAFETY SWITCH
CONTROL PANEL WITH OIL OR AIR CIRCUIT BREAKER
PRIMARY STEAM EQUIPMENT AND DRIVES
STEAM AUXILIARIES
ELECTRICAL ACCESSORIES
WESTINGHOUSE EQUIPMENT SHOWN IN COLOR
STOKER DRIVE...
VARIABLE SPEED TURBINE WITH OIL GOVERNOR CONTROL (FOR WESTINGHOUSE STOKERS ONLY) ...AND/OR SINGLE SPEED SPLASH-PROOF SQUIRREL CAGE MOTOR WITH SUITABLE CONTROL AND VARIABLE SPEED TRANSMISSION OR MULTI-SPEED SPLASH-PROOF SQUIRREL CAGE MOTOR WITH SUITABLE CONTROL ...OR DIRECT CURRENT VARIABLE SPEED MOTOR WITH MAGNETIC STARTER AND FIELD CONTROL (OPERATED BY COMBUSTION CONTROL)
MEDIUM PRESSURE STEAM FOR PLANT DRIVES AND PROCESSES
LOW PRESSURE STEAM FOR PLANT PROCESSES AND BUILDING HEATING
HIGH PRESSURE STEAM
FEED WATER HEATING...
ONE OR MORE STAGES OF FEED HEATING MAY BE USED. STEAM FOR DEAERATING HEATER MAY BE OBTAINED FROM STEAM AUXILIARIES OR EXTRACTED FROM MAIN UNIT AS SHOWN
A-C SWITCHBOARD...
GENERATOR PANELS WITH OIL OR AIR CIRCUIT BREAKERS, INSTRUMENT TRANSFORMERS, METERS, INSTRUMENTS, AND RELAYS, GENERATOR VOLTAGE REGULATORS, CONTROL SWITCHES, AND RHEOSTATS ... AND FEEDER PANELS WITH OIL OR AIR CIRCUIT BREAKERS, METERS, INSTRUMENTS AND RELAYS, CONTROL SWITCHES
D-C TURBINE-GENERATOR...
DIRECT CURRENT FOR EXCITATION, CONTROL EQUIPMENT AND OTHER PLANT USE
D-C SWITCHBOARD...
MAIN AND FEEDER CIRCUIT BREAKERS, PROTECTIVE EQUIPMENT INCLUDING RELAYS, GENERATOR VOLTAGE REGULATOR, DISCONNECTING SWITCHES, METERS, INSTRUMENTS AND SHUNTS
A-C FOR PLANT USE
D-C FOR PLANT USE
TRANSFORMER
TO HIGH PRESSURE STEAM
EXTRACTED STEAM
EXCITER
GENERATOR AIR COOLER AND DUCTS
HOT WATER FOR PLANT PROCESSES
CHILLED WATER RETURN
CHILLED WATER FOR PLANT PROCESSES
WATER AT HIGH PRESSURE FOR HYDRAULIC SERVICES
COMPRESSED AIR
COMPRESSOR
AIR EJECTOR
VACUUM COOLING UNIT
COLD TANK
HEAT EXCHANGER
TO DEAERATING HEATER
COAL HOPPER
BOILER
FEED WATER SUPPLY
HIGH PRESSURE HEATER
EVAPORATOR
DEAERATING HEATER
CONDENSER
AIR EJECTOR
STOKER
ASH HOPPER
ASH EVACUATOR
COAL CONVEYOR
FAN
COAL STORAGE
PUMP
WATER SUPPLY
WATER FROM MAINS
COOLING WATER OUTLET
SOURCE OF COOLING WATER
CONVEYOR DRIVE...
GEARMOTOR WITH STANDARD OPEN OR SPLASH PROOF ENCLOSURE SUITABLE CONTROL WITH REMOTE PUSHBUTTON OPERATION AT SEVERAL POINTS ...OR MOTOR AND SPEED REDUCER WITH SUITABLE CONTROL AND REMOTE PUSHBUTTON OPERATION
FORCED DRAFT FAN DRIVE...
VARIABLE-SPEED TURBINE WITH DIAPHRAGM CONTROL ...OR WOUND-MOTOR MOTOR WITH SUITABLE PRIMARY CONTROL AND MOTOR-OPERATED SECONDARY DRUM CONTROL ...OR SQUIRREL CAGE OR SYNCHRONOUS MOTOR WITH SUITABLE CONTROL WITH OR WITHOUT HYDRAULIC COUPLING (OPERATED BY COMBUSTION CONTROL)
CLINKER-GRINDER DRIVE...
MULTI-SPEED SPLASH-PROOF SQUIRREL-CAGE MOTOR WITH SUITABLE CONTROL
PUMP DRIVE FOR ASH EVACUATOR
CONSTANT SPEED TURBINE ...OR SPLASH-PROOF SQUIRREL CAGE MOTOR WITH SUITABLE CONTROL FOR REMOTE PUSHBUTTON OPERATION
BOILER FEED PUMP DRIVE...
VARIABLE SPEED TURBINE WITH DIAPHRAGM CONTROL ...OR WOUND-ROTOR MOTOR WITH SUITABLE PRIMARY CONTROL AND MOTOR-OPERATED SECONDARY DRUM CONTROL ...OR SQUIRREL CAGE OR SYNCHRONOUS MOTOR WITH SUITABLE CONTROL WITH OR WITHOUT HYDRAULIC COUPLING (OPERATED BY FEEDWATER REGULATOR)
CONDENSATE PUMP DRIVE...
STANDARD OPEN OR SPLASH-PROOF SQUIRREL CAGE MOTOR WITH SUITABLE CONTROL
CIRCULATING PUMP DRIVE...
STANDARD OPEN OR SPLASH-PROOF SQUIRREL-CAGE MOTOR WITH SUITABLE CONTROL AND PUSHBUTTON STARTING ...OR CONSTANT SPEED TURBINE AND REDUCTION GEAR ...OR DUAL DRIVE—BOTH MOTOR AND TURBINE
CHILLED WATER PUMP DRIVE...
SPLASH-PROOF OR STANDARD OPEN SQUIRREL-CAGE MOTOR WITH SUITABLE CONTROL FOR PUSHBUTTON OPERATION
HIGH PRESSURE PUMP DRIVE...
STANDARD OPEN OR SPLASH-PROOF SQUIRREL-CAGE MOTOR WITH SUITABLE CONTROL FOR PUSHBUTTON OPERATION ...OR SYNCHRONOUS MOTOR WITH FULL OR REDUCED VOLTAGE STARTER
COMPRESSOR DRIVE...
HIGH STARTING TORQUE SQUIRREL-CAGE MOTOR WITH SUITABLE CONTROL FOR PRESSURE SWITCH OPERATION ...OR SYNCHRONOUS MOTOR WITH FULL OR REDUCED VOLTAGE STARTER AND PRESSURE SWITCH CONTROL ...OR CONSTANT-SPEED TURBINE WITH OR WITHOUT REDUCTION GEAR
©1930 Westinghouse Elec. & Mfg. Co.

**This chart shows diagrammatically the equipment for a power plant, and the part of that equipment which Westinghouse is prepared to supply.**

**There is a very definite advantage to industry in being able to purchase from one manufacturer so many pieces of equipment that must do their work in proper relation to each other, and to the whole plant.**

**We shall be glad to send you, on request, a large copy of this chart, printed in color, ask us to send you D.M.F. 5873.** J-50296

# Westinghouse *Complete*

POWER

Established 1882 • PHILIP W SWAIN, Editor

# Power for Defense

As this September number of POWER goes to press, the issue of Europe's great war hangs in the balance. We cannot foresee the outcome. One thing only is certain —that no possible turn of events over there can lessen America's need to arm. At the very minimum, ten billions—probably more—will be spent for national defense.

For the next three years, perhaps for the next four or five, Americans will dedicate every effort to the building of ships, the making of planes, tanks, guns and ammunition, the construction of factories, airports, cantonments, the training of soldiers, sailors, air pilots and mechanics.

Steel mills will hum day and night. Railroads and trucks will struggle with the load of industrial transportation. Key men and others will leave their peacetime occupations to be trained in the arts of war. Washington and industry will wrestle with the problems of design, contracts, raw materials, procurement, priorities.

New manufacturing plants and plant extensions will require new supplies of electricity and steam. Thousands of existing plants will be forced to drive their present productive facilities more hours per day and more days per week, thereby putting severe demands on power equipment and personnel.

In this vast hive of mechanized activity, the power engineer will toil at his accustomed task largely unnoticed, unless his power fails because his equipment or his staff "can't take it" or because he can't get the "right" fuel. If this should happen, the ready excuses will not suffice —that the power plant was never intended for such overloads or for continuous operation—that the fuel ordered was not delivered promptly or was not of the customary quality—that the new equipment ordered many months ago has not been delivered. The answer will be "You are an engineer. You saw it coming. You should have foreseen and prepared".

Right now thousands of engineers want to know what's ahead for their plants and how to get ready for it. Our carefully considered answers to both these questions are to be found in this 24-page section "Power for Defense".

As always, our aim is purely practical. The next eight pages, therefore, outline conditions the power engineer must face, and show how engineering foresight can meet them. They tell how to increase capacity by new units or by modernization, how to "stretch" the capacity of an existing plant by shrewd operation, how to protect the plant against possible disorganization of the fuel market or of personnel, how to guard against sabotage.

Following these articles, devoted specifically to the problems ahead, are fifteen pages of solid fact, an elaborate summary of the recently ordered or completed additions to America's power capacity, both steam and hydro —both central station and industrial. Showing the latest actual practice in the various fields of power generation, the tabulations in this section should be a helpful guide to the individual engineer planning to expand his own plant to meet defense requirements.

In addition they offer conclusive proof that power men have not been asleep—that they will likely *keep* ahead of the defense situation because they have long been busy *getting* ahead. These tables are evidence of the foresight that will meet and solve the power problems of 1941 and of the years to come.

*The following 23 pages show where America's power plants stand today and how they can be tuned to meet the demands of the national defense program*

# New Plants, New Units Keep Pace with Demand

## THE FACTS IN BRIEF

Ten or more billions of dollars for armaments to build up our Army and Navy will inevitably boost industry's demand for power and steam —but the effect will be gradual, not immediate

Public power supply, now working about 8% above last year's kwhr, is at an all-time high. There is however, little prospect of abnormally high peak loads for the next six months

Only power shortage in prospect is in TVA's own system, publicly proclaimed inadequate for present needs

Power men, utility and industrial, say they are ready for whatever big push may come

► What will happen to power facilities if "defense" efforts put a 20% increase on America's industrial production? Will the oft-repeated cry of power shortage become a reality just when we most need coordination and smooth efficiency to make all sorts of war supplies?

The worst thing POWER could do would be to lull its readers into a sense of false security on either the rapidity at which power loads can grow or the amounts of added capacity needed. Considering first the immediate future, the probability and extent of increases in electrical peak loads have been considerably overrated because of the wide newspaper publicity accorded every action of the National Defense Committee.

Although over a billion and a half dollars in armament orders have already been placed by the Army and Navy, and plans for smokeless-powder production and ordnance factories have crystallized, little actual increased manufacture of munitions is under way, or will be for several months. Every indication points to a considerable period of readjustment before contracts now being placed can be translated into increased power demands.

Speed is of major importance and new machine tools take time to get, which means that existing shops and facilities are being converted from production of peace-time goods to munitions. Thus, the first impact of armament orders will have to be carried on tools, production lines and other machinery that have been using power right along. Perhaps these tools will be operated at higher output and for longer hours, but they do not, by and large, represent increased connected load. The first probable effect is a sizeable increase in kwhr consumption accompanied by a relatively moderate increase in kw demand.

### Kwhr Use Rises

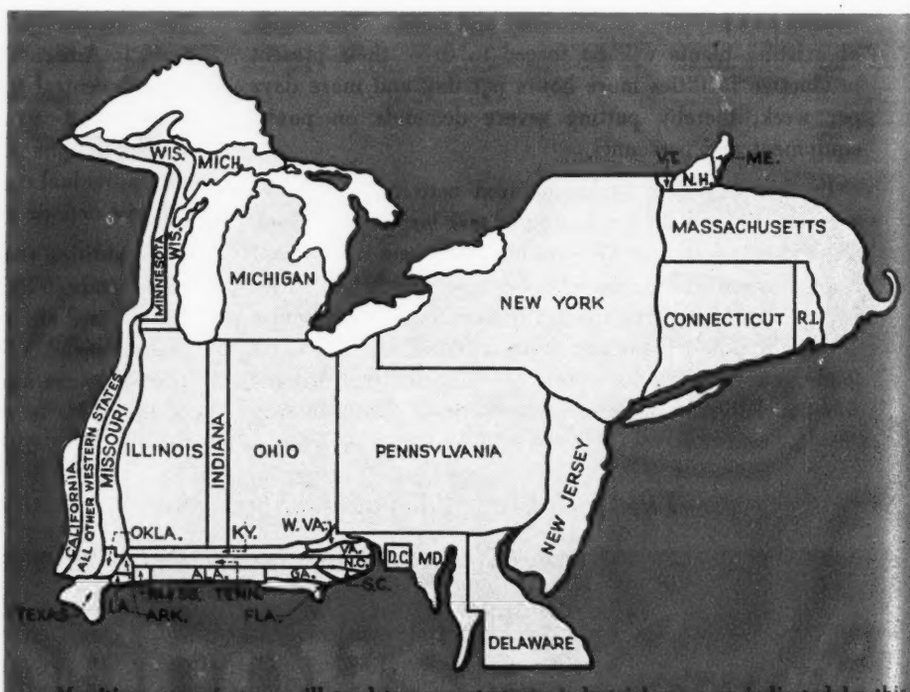
Industry's increase in kwhr use, whether directly for armament or for secondary effects produced by munitions orders, has already been felt by public utilities, which are averaging 8% greater kwhr sales than for corresponding weeks last year. A new high of over 2.6 billion kwhr per week was established in July, a period of the year usually not characterized by record sales. Some estimators doubt that the pick-up from present levels will match the rate of rise in 1939, when rising power loads followed declaration of war in Europe.

If this reasoning is correct, peak kwhr loads and peak demands should not exceed 8-10% over last year and peak demands will probably rise less than kwhr totals. No one seriously questions the ability of the utilities to continue at a level 10% over last year in either kwhr or kw demand, nor are there grounds for expecting serious local shortages to develop.

The utilities, are, in fact, in a much better condition to handle increased industrial load than they were in 1917. Years spent in building residential load as stable business during industrial depressions now return dividends as a cushion for any war boom. Except for a few areas, such as Detroit and Pittsburgh, stable residential and commercial loads account for more than half of total peak demands. Thus, a 10% increase in industrial requirements appears as only a 5% or less need for increased generating capacity.

### Industrials Lack Reserve

The amount of spare capacity each utility system carries, or, for that matter, each industrial plant carries, has always been a matter of determination based on local experience. Many industrial plants have little spare boiler or turbine capacity, relying on week ends for maintenance operations that cannot be arranged during working hours. Central stations, on the other hand, have grown up in a tradition of super-caution in the matter of enforced outage and only in recent years has the proved high reliability of mod-




Munitions manufacture will tend to concentrate in industrial areas as indicated by this map of states distorted in proportion to allocated War Department procurement orders

ern construction been taken into account.

Thus, today's reserves, apparently smaller compared to those of the 1920's, actually represent, kw for kw, more adequate standby. Direct comparison of peak loads and installed generating capacity gives only a first approximation of what is safe operation for a utility system; quality of operating equipment, condition of standby and effectiveness of interconnection must also be considered.

Nowhere is there any evidence of impending power shortage except, strangely enough, in the TVA area. The TVA has publicly announced its lack of capacity to meet present loads by serving notice on purchasers of "surplus" power that present low-water conditions may necessitate some curtailment (only slightly improved by recent rains). Manufacture of aluminum, a more or less strategic material comes in the surplus-power class; thus, it may be considered undesirable from a defense standpoint to insist on the provisions of a surplus-power contract for abrogation of service even under low-water conditions. Since adjacent utility systems could, if permitted, make up any expected shortage (TVA is even now buying off-peak power during night hours), the "lack of power" is not an actual physical shortage. However, the present condition has resulted in authorization two generating units at a new dam, three additional units at existing dams and a steam plant.

These units, like others not yet on a firm-order basis, cannot become effective operating capacity before 1942. This year's operations can be served only by generating units already in operation or practically so. As already stated, present capacity seems adequate for 1940. The best indication of what the situation will be next year comes from a study of generating units under construction—utility, industrial and hydro—with respect to their scheduled dates of initial operation.

### Central Stations Build

Over 700,000 kw of central-station power is scheduled for operation during the latter half of 1940, almost 2,000,000 more for 1941. Industrial lists, difficult to obtain in as complete form, show over 400,000 kw on order or under construction. For industrials, it must be remembered that kw of turbines is not as good a measure of actual increases in power facilities as is steaming capacity of boilers. Details of these installations are presented in the tables on pages 66 through 73.

Stationary diesel and gas engines (see June POWER for technical data on 500 typical installations) will add a block of capacity difficult to estimate but well over 250,000 kw.

Over 200,000 kw of municipal plants will care for part of the normal residential and commercial demands, thus helping to relieve utility systems. About 1,000,000 kw of hydroelectric installations under construction or on order, mostly on government projects, complete the picture.

Location of government hydro plants prevents their contributing much to the industrial areas that will bear the brunt of armament orders. Basic industries that require large amounts of electrolytic or electrorefining power at low cost have been and will be attracted to water-power areas. However, powder plants and shell-loading shops are springing up in already developed industrial areas where steam is the principal source of power supply.

Utilities, which must take over the major part of new manufacturing loads, began ordering new generating capacity a year or more ago. Credit for this foresight must go, at least in part, to their cooperation with the original Power Defense Committee which pointed out possible local shortages in light of Army mobilization plans. Orders were advanced in date, construction begun, and it now seems evident that generating units will begin to operate in advance of industry's ability to employ them.

### Deliveries Still Good

Delivery quotations on large turbines are not yet materially longer than during any normal period of manufacturing activity, that is, from 12 to 18 months depending more on the complexity of design than the size of the unit. At present, about 8 months are needed for large rotor forgings, and the steel industry may turn out to be limiting factor in extending turbine manufacturing periods.

A similar situation prevails in boiler deliveries. Central-station units for high pressure and of large size take from 12 to 15 months, depending on the amount of engineering required and assuming that steel deliveries are not further delayed. Standardized industrial units can still be manufactured within about 8 months from order.

There seems to be no reason to fear that turbine and boiler manufacturers will be unable to continue the present high rate of production. Except for possible priorities not yet in view, present producing capacity is adequate to allow building power plants faster than armament manufacturing plants, no matter whether the latter are supplied by purchased power or their own generating facilities.

Unquestionably, ten billion or more dollars of armament orders for our Army and Navy will boom activity in many industries. But so large an amount of money cannot instantly buy manufactured goods; those responsible for war-materials orders expect delivery of first units in six months to a year, or even longer. Time is the controlling factor in this mobilization—time for placing orders, time for tooling up, time for high-gear production.

Each of these periods has a counterpart in power preparedness—time for planning, time for modernization, time for insuring 24-hour dependable supply of power services.

## FOUR AND A HALF MILLION NEW UTILITY KW FOR DEFENSE

| State | 1940 | 1941 | 1942 |
|---|---|---|---|
| Alabama | | 40,000 | |
| Arizona | 19,386 | | |
| California | 80,000 | 40,000 | 40,000 |
| Colorado | 500 | 32,500 | |
| Connecticut | 25,000 | 25,000 | |
| D. of C. | 50,000 | | 50,000 |
| Florida | 25,800 | 19,000 | 25,000 |
| Georgia | | 95,000 | |
| Illinois | 142,500 | 287,500 | 147,000 |
| Indiana | 72,500 | 85,000 | |
| Iowa | 25,700 | 31,000 | |
| Kansas | 16,585 | 1,000 | |
| Kentucky | 20,000 | 25,000 | |
| Louisiana | 1,500 | 1,000 | 32,000 |
| Maine | 37,800 | | |
| Maryland | 32,500 | 65,000 | |
| Massachusetts | 5,600 | 95,000 | |
| Michigan | 110,000 | 93,800 | |
| Minnesota | 3,000 | | 12,000 |
| Mississippi | | | |
| Missouri | 46,000 | 20,600 | 40,000 |
| Montana | 5,000 | | |
| Nebraska | 2,500 | | |
| Nevada | | | |
| New Jersey | 115,000 | 75,000 | |
| New Mexico | 4,750 | | |
| New York | 183,000 | 160,000 | 105,000 |
| North Carolina | 80,000 | 80,000 | |
| North Dakota | 4,000 | 250 | |
| Ohio | 65,000 | 247,500 | 90,000 |
| Oklahoma | 1,000 | | |
| Oregon | 2,500 | | |
| Pennsylvania | 67,000 | 153,000 | 115,000 |
| Rhode Island | | 40,000 | |
| South Carolina | | | |
| Tennessee | 187,000 | 49,000 | |
| Texas | 39,200 | | 40,000 |
| Utah | 390 | | |
| Virginia | 27,100 | | |
| Washington | | | |
| West Virginia | | 60,000 | 85,000 |
| Wisconsin | 23,000 | 115,000 | 160,000 |
| Total (private) | 1,520,811 | 1,936,150 | 941,000 |
| Total (municipal) | 206,011 | 56,550 | |
| Totals | 1,726,800 | 1,992,700 | 941,000 |
| Grand total | | | 4,660,500 |

# Some Will Meet Loads by Stretching Capacity

▶ SIX MONTHS FROM NOW, America's defense program will be in full swing. If new power units needed are ordered today, they won't be ready for load until 1942. Thus, it is plain that if your boilers, turbines and engines are already pretty well along, you must find means to stretch existing generating capacity for steam, electricity, or both.

The following suggestions should be useful, whether you're in the boat described above or whether you find that your share of the defense load can be carried without adding units if you can only squeeze a little more capacity out of the present plant.

Some of the procedures to be suggested will increase the *actual* capacity of the plant, some the *dependable* capacity, others the *effective* capacity. For example, the *actual* capacity of a turbine can be increased by raising the steam pressure. Preventive maintenance may insure a boiler being on the line when needed and thus increase the *dependable* capacity. Finally, a meter on steam to process may lead manufacturing departments to use less steam. The resulting cut in the peak process steam load is exactly equivalent to an equal increase in boiler capacity. Thus, *effective* capacity of the boiler plant is increased.

### Bigger Output

Every power plant is a chain of equipment elements in which some "weakest link" limits the capacity of the whole plant. The weak link may be carryover from the boiler, in which case a proper blowdown system or correct feedwater treatment may be the means of making a "bigger" plant out of a small one. Most usual limitation is in firing equipment or in draft.

There have been several successful installations of oil burners over stokers to help out on peak loads. Capacity gains up to 30 or 40% have been reported, along with improved stoker performance through induced turbulence. If full-capacity burners are installed, they can also serve as emergency units, backing up one fuel supply with another and safeguarding boiler output against interruptions to fuel supply within the plant. Installation is simple; burners are cut into back or side walls, have separate air supply, and must have protection against furnace heat when not in use.

Lack of draft—natural, forced or induced—accounts for more cases of limited capacity than any other single cause. Many remedies have been found best for individual troubles. The old-fashioned steam or air jet at the base of the stack is still a workable way to help natural draft over peak loads. Usually, addition of forced-draft fans is better if furnace construction permits.

If fans aren't turning out required cfm, wheels or scroll cases may be worn, or ducts may leak. First, check ducts for tightness. Entire furnace-wall setting and duct system can be candled in a few hours. Many small leaks can add up to a large total; the remedy is, of course, pasting up with a sealing compound. If leaks are large, perhaps the best course is to put in new walls or duct plates, if welding won't seal them up.

If fan wheels are worn, blades bent, ducts have sharp angles, then it's a case of deciding whether a new fan wheel will be adequate or whether a new fan of slightly larger capacity is justified. Best idea is to call in a fan manufacturer's representative, find out costs of several possible solutions, time required for delivery, etc. Perhaps the entire job can be finished while factory is tooling up for one new product.

### Feedwater Treatment

If the boiler proper is limiting capacity, little can be done to boost its output. Usual troubles are carryover and scaling of the water side of tubes. Carrying lower water level in drum (after checking permissible amount with manufacturer) may help carryover. Increasing blowdown may also help. Feedwater-treatment experts often can make a boiler "bigger" as well as more efficient, and the results do not take months for equipment manufacture and installation.

In the turbine room, the problem becomes one of best utilization of the boiler plant's maximum output. If blades are eroded or in bad shape, remember

### THE FACTS IN BRIEF

To stretch an existing plant, increase the capacity of the element that limits maximum output

Increase dependable capacity by preventive maintenance—the kind that spots and fixes breakdowns before they occur

Increase effective capacity by eliminating wastes in the transmission and application of all power services in the factory

Possible ceilings in steam and electrical generation are firing, draft, carryover, turbine blading, steam pressure, generator rating, power factor

Greatest service application wastes are misfit motors, visible and invisible leaks of fluids and heat, low power factor, friction, wasteful production machines and operators

1 Search your plant for weak links in equipment, men, methods

2 Plan in detail, how to eliminate danger points, strengthen weaknesses

3 Tune operation to highest pitch of effectiveness and keep it there

that it takes much less time to reblade a wheel or two than to build an entire new turbine. Also, turbine capacity (not generator) can be pushed upward some by increasing steam pressure, if the boiler can stand it. Boosting superheat improves efficiency, but does not usually increase top capacity. Don't overlook the capacity gains possible through clean condensers, cooler circulating water and lower process-steam pressure.

Generators can carry more load if power factor is raised. Capacitors or synchronous motors are standard means. Old machines (15 years or more) were generously built and may be underrated. For information, consult manufacturer, being sure to give serial number of machine. For emergencies, and on your responsibility, he may allow a higher continuous rating, also higher short-time peaks.

Finally, note that suitable instruments, meters and controls, in both boiler room and turbine room, offer increase in peak capacity as well as efficiency.

### Fewer Shutdowns

Industrial power plants are rarely set up for much spare capacity. To offset this, maintenance schedules have to be prepared in advance and they have to be right. Spare parts must be kept on hand, specially strategic ones like stoker iron, spare fan wheel, boiler-tube plugs, feed-pump parts, valves and packing. Tools should hang where they belong.

Consideration for safety, care in operation and forethought in planning are the best safeguards against shutdown. The first calls for low-water alarms on boiler drums, thermometers on lubricating-oil lines, fire extinguishers in order and in place. The second calls for rigid inspection routine, log sheets, personnel trained in several jobs so that lack of one man does not permit ignorant or careless handling of equipment. Third, potential troubles should get attention and repair before they get into the emergency class.

Consider giving the brightest young apprentice, or the cagiest old timer, a week off just to look over the plant from stem to stern and list weak spots that could be touched up. Commissioned with the responsibility, he would turn in a report that might well surprise many a self-satisfied boss.

### Less Waste

Now we come to the problem of making the power plant "bigger" by reducing unnecessary demands on it. Distribution meters are the bloodhounds of such waste. They track down all unnecessary consumption of electricity, steam, water, compressed air.

A portable ammeter, simply clamped around every motor lead, will usually disclose several underloaded motors as well as overloaded ones. Underloading damages both power factor and efficiency. Swapping motors may cure much of the unbalance. New ones are a good investment if they save precious plant capacity.

Watthour meters tell where the bulk of the power load is going. Spot readings during peak periods often suggest rearrangement of departmental operations to ease the plant's peak-load demand. Cooperation between power and production men is good policy in normal times, becomes all-important when plant loads are near the limit in both departments.

Visible leaks in steam and water lines tell a story of careless operation or overworked maintenance staff. The inevitable result in times of stress is failure of staff as well as equipment. Invisible leaks are far worse offenders, since they do not intrude themselves. A survey of all traps, sewer connections and steam exhausts is a good bet to pay back its cost in a few weeks while conserving precious service generating capacity. And don't overlook invisible heat loss through underinsulated hot surfaces or compressed air loss through scored valve seats.

Sooner or later most of the plant's electrical output becomes mechanical power, susceptible to numerous friction losses. Often, the preventable losses in mechanical transmission represent a very substantial potential increase in generating capacity. For minimum friction, couplings, shafts and belts should be well aligned, belts should not run too tight, clutches should run free when disconnected. Also, belts should have sufficient capacity to carry load at reasonable tension with little creep or slip, long slow-speed sleeve-bearing lineshafts should be replaced with modern group drive.

### Secondary Services

Finally, it must be remembered that the generation of such secondary power services as pumped hot and cold water, compressed air, refrigeration and air conditioning, is in fact the consumption of two major power services —steam and electricity. Thus, anything that reduces the power consumption of pumps, compressors, refrigerating machines, etc, increases the effective capacity of the main power plant.

Outstanding wastes in service generation are inefficient pumps and pump drives (these should be checked) and inadequate or too-warm cooling water in the case of air compressors and refrigerating compressors. In many cases, power factor can be improved and plant effective capacity increased by shifting the drive of large compressors to synchronous motors.

# Others Must Modernize in Some of Ten Ways

► Much of the defense material will be produced in manufacturing establishments of less than 200 employees, as indicated by the chart on the next page, recently released by the Planning Bureau of the War Department. Small plants, whether purchasing power or generating their own, are going to play an important part in industrial mobilization.

For central stations, prospect of new load calls for new generating equipment, either on a completely new site, as a new unit for an existing plant, or as a top for an older plant. Thus, utilities must plan 18 months to two years ahead. Preceding pages have shown that central stations are already installing capacity at almost twice their normal pace and are ready to supply kilowatts as needed for defense requirements.

Industrial plants have no such common yardstick. Each is serving and must continue to serve the needs of an individual establishment making one particular kind of goods. The range of requirements is so wide that specific recommendations for increasing power supply must take the form of a check list, to be reviewed in the light of thorough familiarity with local plant needs.

### Three Steps to More Plant

Knowing that armament orders or secondary production resulting from the defense program are in prospect, the industrial plant operator can do three things: (1) check his present plant to see if it can carry the expected loads with 2- or 3-shift operation, (2) place orders as soon as possible for new turbines or boilers, or both, (3) increase maximum reliable output by a program of modernization aimed at eliminating present limitations.

If a careful study shows that existing equipment will not carry high loads dependably for long hours each day, the choice between adding complete new units and bolstering up what is already in the plant depends on the amount of new load and on the condition of the old equipment. Less money and less time are needed for modernization than for new units. However, dependability should be considered and a complete plan worked out rather than hit-or-miss patching.

Nine times out of ten, limit of plant capacity lies in the boiler room. Little can be done to increase electrical generating capacity; much can be accomplished to raise steaming capacity.

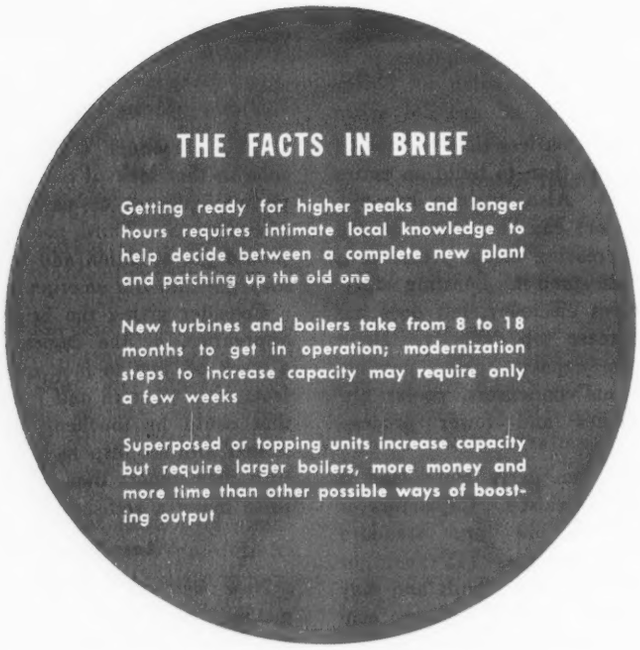
*Furnace walls* of solid refractory that have cracked and bulged can reduce both efficiency and capacity up to 10%, or even more. New types of suspended wall not only restore original tightness of setting but also can be arranged to give appreciable added furnace volume. Delivery of such equipment takes from six to ten weeks. Water walls take longer to manufacture, cost more, but add to boiler heating surface so that capacity can be increased up to 30% if fuel-burning equipment is adequate.

*Stokers* of older types do not have the fuel-burning capacity or versatility of many available today. Some stokers can be installed with practically no changes to the setting, others combine nicely with new furnace arrangements. From both delivery and installation standpoints, installation of a new stoker can be a quick job.

*Draft* limitations are the most common restrictions to increased output. Where natural draft alone is used, installation of a large-capacity, low pressure, forced-draft fan requires little duct work. A fan of this type requires no control equipment other than a hand-operated damper, as it need run only when steaming requirements exceed natural draft.

If forced-draft fans are already in and the limitation is in stack effect, an induced-draft fan will help but it requires considerable ductwork unless the location is particularly favorable. Both types of fan can be installed with only a brief boiler shutdown. If both induced- and forced-draft fans are already installed, fan manufacturers' recommendations should be followed as to whether increased capacity can be obtained by: (1) increased speed, (2) new wheels, (3) new units, complete with casings, suited to existing ductwork.

*Economizers* fit where existing flue-gas temperatures are high and feedwater enters the boiler at temperatures considerably below that of the water in the drum. A rough-and-ready rule is that a percent increase in capacity can be had for every 10-F rise in feedwater temperature or 35-F decrease in flue-gas temperature. If gas temperature is high but feedwater is already heated nearly to saturation, consider certain


THE FACTS IN BRIEF
Getting ready for higher peaks and longer hours requires intimate local knowledge to help decide between a complete new plant and patching up the old one
New turbines and boilers take from 8 to 18 months to get in operation; modernization steps to increase capacity may require only a few weeks
Superposed or topping units increase capacity but require larger boilers, more money and more time than other possible ways of boosting output

special economizers in which steaming takes place.

*Air preheaters* are particularly well suited to oil- or gas-fired installations, where high air temperatures can be safely used and expense for fans and ductwork can be justified. Their use with stokers requires certain precautions—air temperatures can't be brought too high for tuyere openings (more volume of air must be handled) and furnace temperatures, higher with air preheat, must not exceed allowable limits for refractories. Preheaters can provide capacity increases up to 10%.

*Feedwater heaters* not only increase capacity about 1% for every 10-F water rise, as do economizers, but also serve as collectors of waste heat from steam otherwise exhausted to atmosphere. Any Btu's rescued from plant waste, blowdown, or exhaust steam, and returned to the feedwater circuit, show up as net increased output of the boiler.

*Emergency oil burners* installed over stokers can swing peaks or provide fuel flexibility if furnace and setting are amply designed. With boilers built ten years or more ago, having heat-absorbing surface and drums considerably oversize, overfire oil burners offer a quick means of increasing output at low investment cost. Fuel costs, even burning light oils, are increased only during peak loads as coal is burned continuously up to the capacity of the stoker.

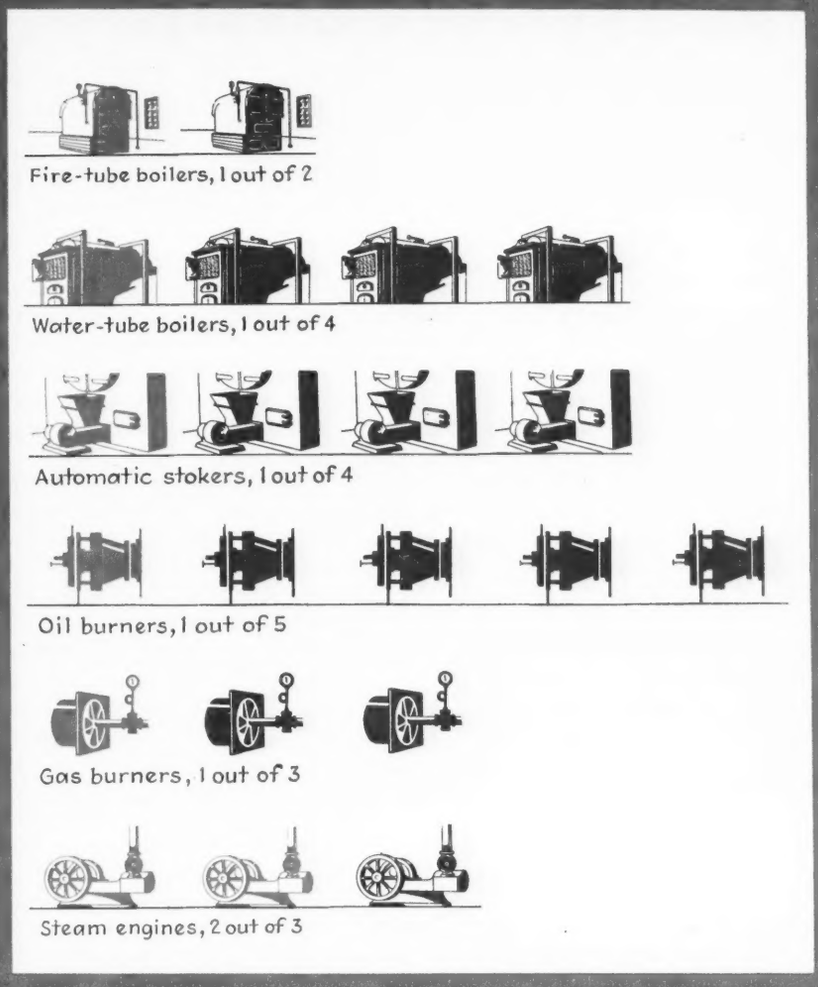
*A separately fired low-pressure boiler* or water heater of standard design can be obtained quickly, requires little brickwork, can be connected to a galvanized-steel temporary flue, and may be exactly the right answer to added demands for process steam. Such an installation suits new process requirements that happen to be some distance from the power plant and which would otherwise require long piping runs.

*Automatic combustion control,* flowmeters, gages and instruments are part of every well-planned modernization. Combined with wide-awake operation, they contribute to increasing the dependable output as well as maintaining efficiency at peak value. Men and operating tools are as important as equipment in times of stress.

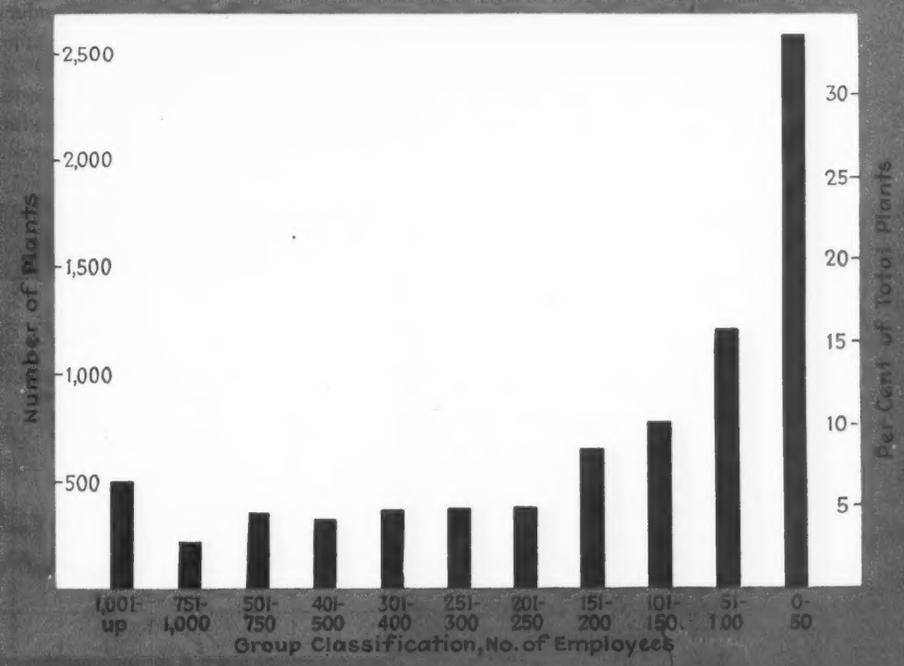
*Purchased power* may be the answer if electric load grows faster than steam load and if extensive building up of plant capacity is required. If existing generating equipment is not suitable for paralleling with utility feeders, part of the factory load can be segregated and supplied with purchased power through interlocked throw-over switches. And don't forget the diesel, which may be just the solution to your problem.



## IN INDUSTRIAL PLANTS, MUCH POWER EQUIPMENT IS MORE THAN 20 YEARS OLD


Fire-tube boilers, 1 out of 2
Water-tube boilers, 1 out of 4
Automatic stokers, 1 out of 4
Oil burners, 1 out of 5
Gas burners, 1 out of 3
Steam engines, 2 out of 3

**Much industrial power equipment is antiquated, so the wise engineer will consider modernization to meet coming loads**




**Many small plants will have a share of armament supplies to be manufactured under the defense program**

# Fuel Prices Going Up, No Shortage Likely

▶ NO ONE, EXPERT OR OTHERWISE, has yet cast doubt on the ability of mines to produce at a rate sufficient to supply any likely increase in industrial demand, either this year or several years from now when the defense program is in high gear. Mines now work well under capacity, and extension of mechanized mining, proceeding rapidly, will increase capacity still further. In addition, mechanization greatly increases output per miner, and thus will probably eliminate the possibility of a shortage of skilled labor in this field.

When the war started last September, the railroads were reminded that transportation failure lay at the bottom of the last war's fuel troubles. The American Association of Railroads immediately issued a statement of complete confidence in the industry's ability to handle any coal-haulage demand, then proceeded to order tens of thousands of new cars, "just in case." These cars came in handy in the big steel boom at the end of last year; then the war quieted down, steel activity dropped off and there were plenty of cars to spare.

The railroads continue to assert that they have ample capacity to meet this winter's demands, and offer figures to prove it. However, steel is booming again and competes with coal for the open-top cars to handle its raw materials and products. Domestic buying has been early this year; utilities seem to be carrying slightly larger stocks (around 3 months average); industrial customers lag with about one month's supply on hand. The net conclusion to be drawn from these conflicting factors is that there is little likelihood of serious trouble, but the fact that railroads have recently limited storage in cars at mines to one day's output shows that the margin of safety isn't excessive.

No one doubts that the railroads will do everything possible to keep abreast of, or slightly ahead of, further demands as the defense program gets rolling. Should they be unable to do so, the answer must lie in long-haul restrictions and in a system of priorities. This would mean a shift to short-haul local fuels for some plants, and the possibility of delayed shipments for anybody and everybody.

### Fuel-Oil Picture

To understand the fuel-oil picture, remember that there are three major ways to refine crudes: straight distillation, thermal cracking, and Houdry, or catalytic, cracking. In the first, both bunker and diesel oils are byproducts; in the second, bunker oils again appear as byproducts; in the last (10% of existing refinery capacity and growing) there need be no fuel byproducts. These facts lead to two conclusions: (1) bunker oil supply depends on gasoline output and thus on gasoline demand, and (2) we may expect the amount of bunker oil resulting from processing a given amount of crude to decrease gradually as refinery methods change (the percentage has dropped from 42 in 1920 to about 25% at present).

At the moment, the usual seasonal supply of bunker oil exceeds the demand. Refinery prices are low. However, the wartime demand for tankers has boosted coastwise transportation cost from unnaturally low rates. The delivered price of oil has, therefore, risen sharply in many localities. Shipping rates have eased off somewhat from extremely high levels reached last Spring, but there is nothing to indicate any immediate further reduction.

### Oil Prices Up

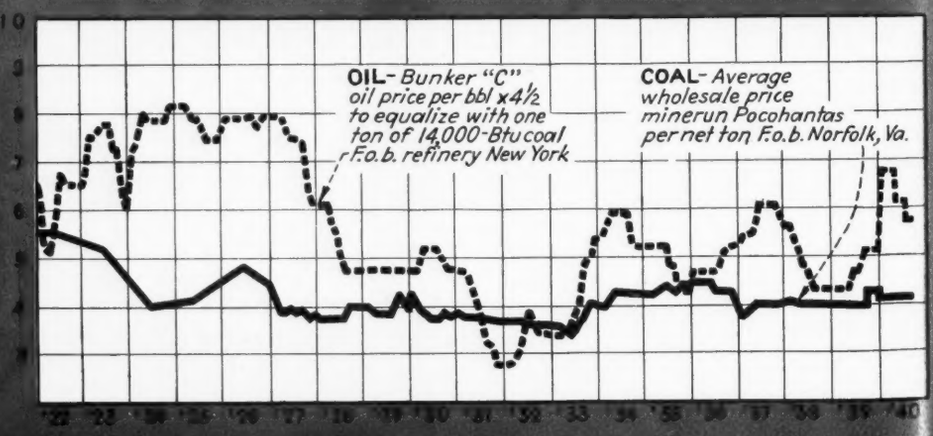
The number and complexity of the influences acting on the oil situation make long-time forecasting difficult and risky. Supply depends on gasoline output and how fast new refining methods reduce the proportion of bunker oil appearing as a byproduct. Industrial use of bunker oil will undoubtedly increase with greater power production. With ample producing and refining capacity and with the alternative of producing fuel oils deliberately instead of as a byproduct (at a higher price, of course) the possibility of a true "shortage" of boiler fuel oil becomes almost unthinkable. However, it seems likely that factors pushing prices upward will predominate for the next few years, especially along the North Atlantic Coast.

In some areas, natural gas plays an important part, although its place in the national fuel picture is small. In producing areas, close to wells of ample capacity, operators need not worry; short-run pipeline additions are relatively simple and quick to make.

## THE FACTS IN BRIEF

Forecast for this fall and winter: No visible possibility of coal shortage; rail facilities probably adequate; slight price rise indicated. Real oil shortage unlikely; higher delivered prices to be expected in many localities

Practical policy for power engineers: Increase fuel stocks, even if it means adding to storage facilities; boost fuel flexibility of existing equipment as much as possible; give fuel situation major consideration in selecting new equipment


Dollars
10
OIL- Bunker "C" oil price per bbl x 4½ to equalize with one ton of 14,000-Btu coal, f.o.b. refinery New York
COAL- Average wholesale price minerun Pocohantas per net ton F.o.b. Norfolk, Va.
'22 '23 '24 '25 '26 '27 '28 '29 '30 '31 '32 '33 '34 '35 '36 '37 '38 '39 '40

This chart shows that coal has been stable compared to heavy fuel oil. Factors causing wide fluctuations in oil prices are still at work

However, there is some possibility that increase in demand at certain centers, particularly those served by long pipelines, may tax facilities severely before capacity at the point of use can be increased. Operators in these areas should check this point carefully.

What does all this add up to, in terms of a practical fuel policy? Here are three recommendations, all on the safe side: (1) *Build up stocks of fuel, increasing storage facilities where these are limited.* This will cushion against short-time, local disruptions of supply. Since there seems to be no likelihood of falling prices on any fuel, the only economic disadvantage of this step lies in the need for tying up capital. Under the circumstances, the cost looks negligible when compared with the protection offered.

(2) *Any steps taken now to increase the range of fuels that can be burned will serve also as insurance against eventualities.* For coal-burning plants, this means preparing to carry the load with lower-grade coal, if necessary. Oil and gas-burning plants should give some thought to shifting to coal; this is a more far-reaching and expensive change than from coal to oil and so requires more planning. In many plants, ability to burn both solid and liquid (or gaseous) fuel may prove a very valuable asset in the next few years or so.

(3) *Insist on fuel versatility in new equipment.* In most cases a slight additional investment will insure ample furnace volume and burning equipment capable of yielding needed output even with low-grade coals.

# Every Plant Will Face Personnel Problems

### THE FACTS IN BRIEF

Make sure your plant can carry on if you lose one or more men to the military services. Make your staff versatile. Hang on to the "old timers" — their experience is invaluable

To guard against sabotage, keep out unauthorized visitors, fence and floodlight plant grounds, watch the coal intake. Of all protective devices, the best are loyal and shrewd employees

▶ Power-plant personnel, always an important problem, will demand far more attention as the defense program swings into its stride. Before the end of the year some plants will see a few of their best men march off to train with the armed forces.

Remembering the lessons of the past, the War Department will do what it can to avoid damaging industrial organizations to a degree that might endanger essential production. On the other hand, it can't worry about causing you a little inconvenience. The fact that you consider a certain man "essential" does not necessarily mean that the government will agree and pass him by when the names are called.

So look over your staff right now and figure what you would do if your most valuable man left you on short notice. What would you do if you should lose two or three? If your plant is one likely to add shifts or days to turn out defense orders, carry the thinking one step further. What would you do if several of your key men were called to the service just when the big load came on your plant?

Some plants will decide, we feel, that it is good insurance to add a man or two right now—get them in training. *Every* plant should study its entire personnel problem, make sure each man knows his job and enough about the other fellow's so he can pinch hit in an emergency.

This line of thinking inevitably leads to a new evaluation of the "old timer" in the power plant. He's been operating for many years. He's far beyond military age. He's in line to retire pretty soon. In view of the present defense situation wouldn't it be well to postpone that retirement for several years?

A good staff is important even in normal times. Under conditions of strain and stress it becomes a necessity. The lesson is obvious. Everything possible must be done to hold good men on the job. Their duties should be rotated somewhat to make the staff as versatile as possible.

#### Sabotage

We are not at war with any nation. We don't have to guard against the chance that an enemy plane will drop a bomb down the smoke stack. Nevertheless there is some danger of attempted sabotage of power plants of key importance in the national defense program.

Since no wave of plant sabotage has yet appeared, we would suggest only ordinary common-sense precautions for the time being. These might well include locking the power-plant door, fencing and floodlighting the plant and coal yard, requiring authorized passes of all visitors and permitting no visits except for known and good reasons.

It seems generally agreed by the engineers we have consulted that the coal supply of the plant is the chief focal point of sabotage, since great damage can be done to pulverizer or furnace by a bomb or stick of dynamite, or a handful of dynamite caps entering with the coal. Scrap metal entering the pulverizer is another hazard. Most of the danger from such sources can be eliminated by watchfulness and by screens at the coal elevator and at other points.

Of all protective devices, the best, we feel, are loyal and shrewd employees, men who have proved their dependability and will keep an eye out for all potential dangers.

# Typical Central Stations Installed or

Compiled by S A Tucker
*Associate Editor*

| Company | Location | Plant Name | Consulting Engineer | First Operation, Year Units | Pressure, Lb | Steam Temperature, F | BOILERS Number | BOILERS Capacity, Each, 1000 Lb per Hr | BOILERS Manufacturer | BOILERS Boiler Surface, 1000 Sq Ft | Waterwall Surface, 1000 Sq Ft | Furnace Volume, 1000 Cu Ft | Furnace Bottom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1000 LB AND ABOVE** | | | | | | | | | | | | | |
| Montaup Electric Co | Somerset, Mass | Somerset | Stone & Webster | 1941 | 1950 | 960 | 1 | 650 | CE | 21.0 | 21.0 | 31.0 | ST |
| Consolidated Edison Co | New York, N. Y. | Sherman Creek | | 1942 | 1600 | 950 | .... | .... | .... | .... | .... | .... | .... |
| Central New York Power Corp | Oswego, N. Y. | Oswego | | 7-41 | 1500 | 950 | 1 | 900 | BW | .... | .... | .... | ST |
| Pacific Gas & Electric Co | San Francisco, Calif. | Martinez | | 1940 | 1500 | 950 | 3 | 200 | BW | 1.5 | 2.5 | 8.0 | .... |
| Pacific Gas & Electric Co | San Francisco, Calif. | Avon | | 7-40 | 1500 | 950 | 3 | 200 | BW | 1.5 | 2.5 | 8.0 | .... |
| Pacific Gas & Electric Co | San Francisco, Calif. | Oleum | | 1940 | 1500 | 950 | 3 | 200 | BW | 1.5 | 2.5 | 8.0 | .... |
| Consolidated Edison Co | New York, N. Y. | Waterside | | 7-41 | 1485 | 925 | 2 | 615 | BW | 12.9 | .... | .... | ST |
| | | | | 10-40 | 1475 | 925 | 2 | 615 | CE | 10.8 | 6.8 | .... | ST |
| Public Service Elec & Gas Co | Burlington, N. J. | Burlington | | 12-40 | 1475 | 950 | 2 | 550 | BW | 7.2 | 6.3 | 23.5 | ST |
| Public Service Elec & Gas Co | Jersey City, N. J. | Marion | | 6-41 | 1475 | 950 | 2 | 550 | BW | 7.2 | 6.3 | 23.5 | ST |
| Metropolitan Edison Co | West Reading, Pa. | W Reading | Utility Mgmt Corp | 5-41 | 1400 | 900 | 2 | 275 | CE | 5.6 | 4.9 | 15.7 | DB |
| Atlantic City Electric Co | Atlantic City, N. J. | Atlantic City | Am G & E Serv Corp | 8-41 | 1385 | 955 | 1 | 300 | FW | 3.7 | 7.7 | 14.6 | DB |
| Dayton Power & Light Co | Dayton, Ohio | Millers Ford | Columbia Engrg Corp | 10-40 | 1375 | 900 | 2 | 375 | BW | 4.8 | 3.1 | .... | DB |
| Ohio Power Co | Philo, Ohio | Philo | Am G & E Serv Corp | 11-41 | 1375 | 950 | 2 | 450 | BW | .... | 9.4 | 19.8 | ST |
| Philadelphia Electric Co | Chester, Pa | Chester | | 1941 | 1350 | 935 | 2 | 600 | BW | 11.5 | .... | 27.0 | ST |
| Narragansett Electric Co.‡ | Providence, R. I. | Manchester St | New England Pwr Serv Co | 1941 | 1350 | 915 | 1 | 430 | CE | .... | .... | .... | .... |
| Iowa Power & Light Co | Des Moines, Iowa | Des Moines, No. 2 | | .... | 1340 | 925 | 1 | 410 | CE | 9.7 | 6.2 | 15.7 | DB |
| Commonwealth Edison Co | Chicago, Ill. | Northwest | Sargent & Lundy | 10-40 | 1325 | 935 | 3 | 425 | CE | 10.6 | 5.9 | 24.3 | ST |
| Public Service Co of No Ill | Joliet, Ill. | Joliet | Sargent & Lundy | .... | 1325 | 935 | 2 | 350 | BW | 10.0 | .... | 17.5 | ST |
| Consol Gas, Elec Lt & Pwr Co | Baltimore, Md. | Westport | | 1940 | 1325 | 915 | 2 | 330 | CE | 5.3 | 5.3 | 16.9 | DB |
| Boston Edison Co | Boston, Mass | L Street | Jackson & Moreland | 5-39 | 1300 | 910 | 2 | 375 | CE | 5.6 | 5.7 | 17.4 | DB |
| West Penn Power Co | Power, W. Va | Windsor | Sanderson & Porter | 8-41 | 1300 | 925 | 2 | 750 | CE | 13.3 | 10.0 | 39.3 | ST |
| Wisconsin Electric Power Co | Milwaukee, Wis | Commerce St | | 10-41 | 1295 | 900 | 1 | 375 | CE | 24.0 | 6 4 | 29.1 | DB |
| **800 TO 999 LB** | | | | | | | | | | | | | |
| Georgia Power Co | Macon, Ga | Macon | Commonwealth & So | 6-41 | 950 | 900 | 1 | 400 | CE | 18.0 | 6.2 | .... | DB |
| Alabama Power Co | Mobile, Ala | Chickasaw | Commonwealth & So | 5-41 | 950 | 900 | 1 | 400 | CE | 18.0 | 6.2 | .... | DB |
| Detroit Edison Co | Detroit, Mich | Delray | | 6-42 | 950 | 910 | 2 | 344 | BW | 7.0 | 4.6 | 27.5 | .... |
| Ohio Edison Co | Toronto, Ohio | Toronto | Commonwealth & So | 9-40 | 900 | 900 | 1 | 400 | BW | 3.5 | 5.5 | 17.1 | ST |
| Florida Power & Light Co | Ft Lauderdale, Fla | Lauderdale | Ebasco Services | 12-40 | 900 | 908 | 1 | 300 | RS | 10.8 | 5.7 | 12.0 | .... |
| Consumers Power Co | Bay City, Mich | John C Weadock | Commonwealth & So | 4-41 | 900 | 900 | 1 | 400 | FW | 7.5 | 4.1 | 21.9 | DB |
| Central Illinois Light Co | Peoria, Ill | East Peoria | Commonwealth & So | 3-41 | 900 | 900 | 1 | 375 | RS | 23.3 | 11 5 | 23 5 | DB |
| Duke Power Co | Cliffside, N. C. | Cliffside | | 7-40 | 900 | 900 | 2 | 375 | CE | 18.2 | 6.1 | 19.3 | DB |
| Consol Gas, Elec Lt & Pwr Co | Baltimore, Md. | Westport | | 1941 | 900 | 915 | 1 | 550 | BW | 6.2 | 7.1 | 28.9 | DB |
| Consumers Power Co | Comstock, Mich. | Bryce E Morrow | Commonwealth & So | 10-41 | 900 | 900 | 1 | 550 | FW | 9.1 | 8.3 | 29.2 | DB |
| Duke Power Co | Spencer, N. C. | Buck | | 7-41 | 900 | 900 | 2 | 375 | CE | 18.2 | 6.1 | 19.3 | DB |
| Cleveland Elec Illum Co | Cleveland, Ohio | Lake Shore | | 5-41 | 890 | 910 | 2 | 650 | BW | 11.5 | .... | 27.0 | ... |
| Marion-Reserve Power Co | Prospect, Ohio | Scioto | Stone & Webster | 3-41 | 875 | 835 | 1 | 150 | BW | 14.0 | 1.5 | 6.4 | .... |
| Connecticut Power Co | Stamford, Conn | Stamford | Stone & Webster | 7-41 | 875 | 915 | 1 | 300 | BW | 6.3 | 6.3 | 20.3 | DB |
| Union Electric Co. of Ill | Venice, Ill. | Venice No. 2 | Stone & Webster | 8-41 | 850 | 900 | 2 | 360 | CE | 9.8 | 7.5 | 30.0 | DB |
| Moline-Rock Island Mfg Co | Moline, Ill. | Moline | United Lt & Pwr Serv Co | 8-41 | 835 | 825 | 2 | 100 | BW | 9.1 | 2.4 | 5.4 | .... |
| Toledo Edison Co | Toledo, Ohio | Acme | Electric Advisers | 8-41 | 825 | 825 | 2 | 350 | BW | 16.5 | 5.3 | 17.9 | ST |
| Kansas Power & Light Co | Abilene, Kan | Riverside | | 6-40 | 800 | 825 | 1 | 189 | CE | 5.0 | 4.0 | 10.3 | .... |
| **500 TO 799 LB** | | | | | | | | | | | | | |
| Potomac Electric Power Co | Washington, D. C. | Buzzard Point | Stone & Webster | 10-40 | 775 | 900 | 1 | 525 | CE | 17.2 | 6.4 | 25.0 | ST |
| | | | | 1942 | 775 | 900 | 1 | 525 | CE | 17.2 | 6.4 | 25.0 | ST |
| Dresser Power Corp | W Terre Haute, Ind. | Dresser | Sargent & Lundy | 2-41 | 775 | 910 | 2 | 250 | CE | 6.6 | 4.4 | .... | ST |
| Rochester Gas & Elec Co | Rochester, N. Y. | Station No. 3 | | 7-41 | 750 | 775 | 1 | 250 | CE | 15.3 | 4.0 | 13.7 | DB |
| Central Ill. Public Service Co | Hutsonville, Ill. | Hutsonville | | .... | 725 | 835 | 4 | .... | CE | .... | .... | .... | .... |
| Sioux City Gas & Elec Co | Sioux City, Iowa | Water Street | B F Wood | 9-39 | 725 | 700 | 1 | 75 | CE | 7.4 | 1.6 | 31.6 | .... |
| Iowa Elec Lt & Pwr Co | Cedar Rapids, Iowa | Cedar Rapids | | 12-40 | 675 | 775 | 1 | 300 | SB | 16.6 | 4.8 | 16.1 | DB |
| Holyoke Water Power Co | Holyoke, Mass. | Holyoke No. 1 | Jackson & Moreland | 8-40 | 675 | 750 | .... | .... | .... | .... | .... | .... | .... |
| Central Illinois Public Serv Co | Hutsonville, Ill. | Hutsonville | Sargent & Lundy | 4-40 | 665 | 835 | 2 | 150 | CE | 14.8 | 3.0 | 8.8 | DB |
| | | | | 4-41 | 665 | 835 | 2 | 150 | CE | 14.8 | 3.0 | 8.8 | DB |
| Wisconsin Power & Light Co | Sheboygan, Wis. | Edgewater | Sargent & Lundy | .... | 650 | 800 | .... | .... | .... | .... | .... | .... | .... |
| United Illuminating Co | Bridgeport, Conn. | Steel Point | Westcott & Mapes | 11-41 | 650 | 850 | 2 | 115 | BW | 9.5 | 2.1 | 5.9 | DB |
| National Lt & Pwr Co, Ltd | Moose Jaw, Sask. | Moose Jaw | Federal Engrg Co | 1-40 | 650 | 800 | 1 | 120 | FW | 10.7 | 3.0 | 8.7 | DB |
| Otter Tail Power Co | Wahpeton, N. D. | Kidder | | 11-39 | 650 | 825 | 1 | 140 | RS | 9.4 | 2.1 | .... | DB |
| Derby Gas & Electric Co | Derby, Conn. | Derby | Gibbs & Hill | 6-40 | 650 | 750 | 1 | 125 | BW | 11.5 | .... | 5.9 | DB |
| Virginia Public Serv Gen Co | Alexandria, Va. | Alexandria | Utility Mgmnt Corp | 11-40 | 650 | 825 | 2 | 80 | CE | 6.8 | 0.8 | 3.4 | DB |
| Delmarva Power Co | Vienna, Md. | Vienna | Utility Mgmnt Corp | 12-40 | 650 | 825 | 1 | 80 | CE | 6.8 | 0.8 | 3.6 | DB |
| Hawaiian Electric Co | Waiau, Oahu, T. H. | Waiau | | 8-40 | 650 | 825 | 1 | 190 | BW | 16.2 | .... | 7.6 | .... |
| Commonwealth Edison Co | Pekin, Ill. | Powerton | Sargent & Lundy | 5-40 | 650 | 725 | 3 | 450†† | BW | 30.4 | 7.0 | 20.5 | ST |
| Georgia Power Co | Atlanta, Ga | Atkinson | Commonwealth & So | 11-41 | 525 | 750 | 1 | 650 | CE | 32.3 | 8.2 | .... | DB |
| **400 TO 499 LB** | | | | | | | | | | | | | |
| Duquesne Light Co.† | Pittsburgh, Pa | James H Reed | | 1941 | 475 | 760 | 1 | 350 | BW | 28.1 | 3.9 | 18.1 | .... |
| S. Carolina Elec & Gas Co | Parr, S C | Parr | Utility Mgmnt Corp | 9-40 | 450 | 750 | 1 | 162 | FW | 14.6 | .... | 12.1 | DB |
| Community Public Service Co | Fort Worth, Texas | Lordsburg | | 6-39 | 450 | 750 | 1 | 70 | BW | 6.0 | .... | 2.5 | DB |
| Dakota Power Co | Rapid City, S. D. | Rapid City | Loeb & Eames | 10-40 | 450 | 750 | 1 | 50 | BW | 5.2 | .... | 2.2 | DB |
| Gulf Public Service Co | Jacksonville, Tex. | Jacksonville | Loeb & Eames | 8-40 | 450 | 750 | 1 | 50 | BW | 5.2 | .... | 2.2 | DB |
| Northern States Power Co | LaCrosse, Wis. | French Island | P U Engrg & Service Corp. | .... | 450 | 750 | 1 | 150 | FW | 10.6 | 1.8 | 6.1 | .... |
| Northern States Power Co | St. Cloud, Minn. | St. Cloud | P U Engrg & Service Corp. | .... | 450 | 750 | 1 | 125 | HV | 9.7 | 1.6 | 5.5 | .... |
| Laclede Power & Light Co | St Louis, Mo. | Laclede | | .... | 425 | 750 | .... | .... | .... | .... | .... | .... | .... |
| Western Public Service Co | Scotts Bluff, Neb. | Scotts Bluff | | 10-40 | 410 | 760 | 1 | 45 | EC | 5.3 | 0.4 | 3.0 | .... |
| Indianapolis Pwr & Lt Co | Indianapolis, Ind. | Harding Street | Gibbs & Hill | 5-41 | 400 | 700 | .... | .... | .... | .... | .... | .... | .... |
| Raton Public Service Co | Raton, N. M. | Raton | | 12-40 | 400 | 750 | .... | .... | .... | .... | .... | .... | .... |
| Southern Colorado Power Co | Pueblo, Colo. | Pueblo | P U Engrg & Service Corp. | 6-41 | 400 | 750 | 1 | 90 | HV | 12.5 | 2.4 | 4.8 | DB |
| **BELOW 400 LB** | | | | | | | | | | | | | |
| United Illuminating Co | New Haven, Conn. | English | Westcott & Mapes | .... | 375 | 620 | 2 | 100 | BW | 15.1 | .... | 3.6 | .... |
| Central Power & Light Co | Corpus Christi, Tex. | Nueces Bay | Sargent & Lundy | 7-40 | 375 | 825 | 2 | 85 | CE | .... | .... | .... | DB |
| Appalachian Elec Pwr Co | Kenova, W. Va. | Kenova | | .... | 300 | 700 | 1 | 175 | CE | 15.4 | 4.2 | 9.0 | DB |
| Central Ill. Elec & Gas Co | Rockford, Ill. | Rockford | Stone & Webster | 7-40 | 275 | 750 | 1 | 175 | BW | 14.6 | .... | 5.4 | .... |
| Northwestern Public Serv Corp | Mitchell S. D. | Mitchell | Power Serv Corp | 10-39 | 275 | 650 | 1 | 43 | EM | 5.0 | 0.1 | 1.5 | .... |
| Kansas City Pwr & Lt Co | Kansas City, Mo. | Northeast | | 6-40 | 275 | 725 | .... | .... | .... | .... | .... | .... | .... |
| Maritime Electric Co | Charlottetown, P.E.I. | Charlottetown | | .... | 250 | 650 | 1 | 45 | FW | 4.9 | 0.4 | .... | .... |
| Virginia Public Service Co | Hampton, Va. | Hampton | Utility Mgmnt Corp | 3-40 | 205 | 525 | 1 | 70 | CE | 6.6 | 0.5 | 2.6 | .... |
| Keystone Public Service Co | Oil City, Pa. | Oil City | Utility Mgmnt Corp | .... | 200 | 600 | 1 | 100 | FW | 8.6 | 2.6 | 6.3 | .... |
| Houston Lighting & Power Co | Houston, Texas | Gable Street | Ebasco Services | 8-40 | 200 | 500 | 1 | 120 | RS | 11.4 | .... | 4.3 | .... |
| Central Hudson Gas & Elec Corp. | Poughkeepsie, N. Y. | Poughkeepsie | | 3-41 | 185 | 482 | 1 | 100 | FW | 8.6 | 5.2 | 6.5 | DB |

*A* —Air cooling
*AC* —Allis-Chalmers Mfg Co
*AS* —Acid sludge
*B* —Bagasse
*BA* —Bark
*BD* —Badenhausen
*BFG* —Blast-furnace gas
*BI* —The Bigelow Co
*BL* —Black liquor
*BM* —Bellis & Morcom
*BW* —Babcock & Wilcox Co
*C* —Coal, bituminous
*CA* —Coal, anthracite
*CB* —Cleaver-Brooks Co
*CE* —Combustion Engineering Co
*CF* —Compensating-feed stoker
*CG* —Chain-grate stoker
*COG* —Coke-oven gas
*CY* —Cyclone
*D* —Dual drive
*DB* —Dry bottom
*DL* —De Laval Steam Turbine Co
*EC* —Erie City Iron Works
*E K* —E Keeler Co
*EL* —Elliott Co
*EM* —Edge Moor Iron Works
*EP* —Electrostatic precipitator
*F* —Cinder-eliminator fan
*FS* —Filer & Stowell Co
*FW* —Foster Wheeler Corp
*Fu* —Future installation
*G* —Gas
*GE* —General Electric
*H* —Hydrogen cooling
*HS* —Hoffit stoker
*M* —Motor drive
*MI* —Murray Iron Works
*MS* —Moore Steam Turbine Corp
*O* —Oil
*OF* —Overfeed stoker

# Under Construction Since January, 1939

| Heat Liberation, 1000 Btu per Cu Ft | Economizer Surface, per Boiler, 1000 Sq Ft | Air-Heater Surface, per Boiler, 1000 Sq Ft | FD FANS: Number per Boiler | FD FANS: Capacity Each, 1000 CFM | FD FANS: Drive | ID FANS: Number per Boiler | ID FANS: Capacity Each, 1000 CFM | ID FANS: Drive | Firing | FUEL: Heating Value, 1000 Btu per Lb | FUEL: Ash-Fusion Temp, F | Ash Removal | FEED PUMPS: Number | FEED PUMPS: Drive | TURBINES: Manufacturer | TURBINES: Speed, RPM | TURBINES: Capacity, 1000 Kw | TURBINES: Backpressure, Lb Abs | TURBINES: No. Bleed Points | TURBINES: Bleed Press, Lb Abs | Condenser Surface, 1000 Sq Ft | Generator Cooling, Air or Hydrogen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25.0 | 24.0 | 110.0 | 2 | .... | M | 2 | .... | M | PC, O | 14.2–18.4 | 2300 | .... | 3 | T | GE | 3600 | 20.0 | 385.0 | .. | ..... | .... | H |
| ..... | .... | .... | .... | .... | .. | .... | .... | .. | ..... | ..... | ..... | .... | .... | ..... | WE | 3600 | 50.0 | 215.0 | 1 | 415 | .... | H |
| ..... | .... | .... | 2 | .... | M | 2 | .... | M | PC | 14.5 | 2550 | .... | 3 | M | GE | 1800 | 80.0 | 0.5 | 6 | ..... | .... | H |
| 31.9 | 5.1 | 12.5 | 1 | 67 | M | 1 | 134 | M | PCk,G,O,S | ..... | ..... | .... | 3 | T | GE | 3600 | 35.0 | 0.7 | 3 | 240–20 | 18.0 | H |
| 31.9 | 5.1 | 12.5 | 1 | 67 | M | 1 | 134 | M | PCk,G,O,S | ..... | ..... | .... | 3 | T | GE | 3600 | 35.0 | 0.7 | 3 | 240–20 | 18.0 | H |
| 31.9 | 5.1 | 12.5 | 1 | 67 | M | 1 | 134 | M | PCk,G,O,S | ..... | ..... | .... | 3 | T | GE | 3600 | 35.0 | 0 7 | 3 | 240–20 | 18.0 | H |
| 30.0 | 22.6 | 148.0 | 2 | 100 | M | 1 | 300 | M | PC | 14.7 | 2570 | EP | 3 | 2M, 1T | GE | 3600 | 65.0 | 215.0 | .. | ..... | .... | H |
| 27.0 | 20.0 | 108.2 | 2 | 100 | M | 1 | 300 | M | PC | 14.7 | 2570 | EP | 3 | T | WE | 3600 | 65.0 | 215.0 | .. | ..... | .... | H |
| 27.3 | 11.5 | 99.4 | 1 | 160 | M | 1 | 275 | M | PC,O | 14.2–18.4 | 21–2600 | EP | 4 | 3M, 1T | GE | 3600 | 100.0 | 0.5 | 5 | 320–7 | 55.0 | H |
| 27.3 | 11.5 | 99.4 | 1 | 160 | M | 1 | 275 | M | PC,O | 14.2–18.4 | 21–2600 | EP | 4 | 3M, 1T | GE | 3600 | 50.0 | 215.0 | 2 | 450–290 | .... | H |
| 25.4 | 8.4 | 40.4 | 2 | 55 | M | 2 | 93 | M | PC | 13.8 | 2700 | .... | 3 | T | WE | 3600 | 20.0 | 280.0 | .. | ..... | .... | A |
| 25.1 | 13.0 | 23.2 | 1 | 81 | M | 1 | 155 | M | PC | 13.6 | 2200 | C | 2 | M | GE | 3600 | 25.0 | 0.5 | 4 | 380–13 | 17.8 | H |
| ..... | 17.8 | 26.4 | 1 | 128 | M | 1 | 240 | M | PC | 13.7 | 2850 | EP | 3 | T | GE | 3600 | 30.0 | 245.0 | .. | ..... | .... | H |
| 27.9 | 10.0 | 66.5 | 1 | .... | M | 2 | .... | M | PC | 11.5 | 2000 | .... | 3 | M | GE | .... | 85.0 | 0.5 | 5 | 371–5 | 54.5 | H |
| 28.0 | 17.8 | 59.6 | 2 | 102 | M | 2 | 187 | M | PC | 14.1 | 2200 | C | 4 | T | GE | 3600 | 50.0 | 280.0 | .. | ..... | .... | H |
| ..... | ..... | ..... | 2 | 65 | M | 2 | 118 | M | PC,O | ..... | 2200 | .... | 2 | 1M, 1T | GE | 3600 | 40.0 | 0.5 | 4 | ..... | 28.5 | H |
| 24.9 | 8.6 | 31.2 | 2 | 54 | M | 2 | 103 | M | PC | 9.2 | 1925 | C | 2 | 1-M, 1-T | AC | 3600 | 35.0 | 0.5 | 5 | 511–6 | 34.0 | A |
| 23.0 | 11.6 | 62.7 | 1 | 145 | M | 1 | 240 | M | PC | 10.0 | 2100 | EP | 4 | 3T, 1M | AC | 3600 | 50.0 | 245.0 | .. | ..... | .... | H |
| 27.7 | 12.7 | 55.6 | 2 | 116 | M | 2 | 200 | M | PC | 11.5 | 1920 | .... | 3 | T | GE | 3600 | 25.0 | 325 | .. | ..... | .... | H |
| 24.7 | 9.6 | 29.8 | 1 | 100 | M | 1 | 195 | M | PC | 14.1 | 22–2700 | EP | 2 | T | GE | 3600 | 25.0 | 205.0 | .. | ..... | .... | A |
| 28.8 | 12.1 | 53.3 | 1 | 120 | M | 1 | 206 | M | PC,O | 14.9–18.2 | 2600 | EP | 4 | 2M, 2T | WE | 3600 | 25.0 | 315.0 | .. | ..... | .... | A |
| 24.0 | 15.2 | 47.8 | 2 | 115 | M | 2 | 225 | T | PC | 11.5–12.5 | 2100 | .... | 4 | 2M, 2T | GE | 3600 | 60.0 | 245.0 | .. | ..... | .... | H |
| 16.1 | .... | 66.5 | 2 | 70 | M | 2 | 96 | M | PC | 12.8 | 2250 | EP | 2 | T | AC | 3600 | 35.0 | 0.7 | 4 | 369–13 | 21.5 | H |
| 26.6 | .... | 45.1 | 1 | 140 | M | 1 | 250 | M | PC | 13.5–14.0 | 21–2700 | .... | 2 | M | WE | 3600 | 40.0 | 1.0 | 5 | 316–9 | 31.3 | H |
| 26.6 | .... | 45.1 | 1 | 140 | M | 1 | 250 | M | PC | 12.0–13.5 | 21–2700 | .... | 2 | M | WE | 3600 | 40.0 | 1.0 | 5 | 316–9 | 26.8 | H |
| 16.3 | 17.7 | 28.0 | 2 | 53 | M | 1 | 189 | M | C,BFG | 13.5 | 2500 | .... | 2 | 1M, 1T | GE | 1800 | 75.0 | 0.5 | 4 | 211–7 | 53.6 | A |
| 31.6 | 15.9 | 77.4 | 1 | 125 | M | 1 | 220 | M | PC | 12.5 | 2200 | .... | 3 | 2M, 1T | WE | 3600 | 35.0 | 0.5 | 4 | 137–7 | 33.2 | H |
| 31.2 | 7.0 | 49.7 | 1 | 94 | M | 1 | 145 | M | O | 18.3 | ..... | .... | 3 | 2M, 1T | WE | 3600 | 25.0 | 0.5 | 4 | 221–12 | 21.0 | H |
| 24.5 | 28.5 | 54.1 | 1 | 130 | M | 1 | 215 | M | PC | 13.5 | 2400 | .... | 3 | M | GE | 3600 | 35.0 | 0.5 | 5 | 246–6 | 33.0 | H |
| 21.9 | 11.5 | 56.0 | 1 | 125 | M | 1 | 205 | M | PC | 9.8 | 1950 | .... | 1 | M | WE | 3600 | 35.0 | 0.5 | 4 | 137–7 | 30.2 | H |
| 24.8 | .... | 38.9 | 1 | 117 | M | 1 | 215 | M | PC | 12.5–14.5 | 21–2800 | .... | 4 | 3M, 1T | GE | 3600 | 40.0 | 1.0 | 4 | 212–6 | 33.0 | H |
| 23.4 | 13.4 | 66.6 | 2 | 75 | M | 2 | 135 | M | PC | 14.1 | 22–2700 | EP | 2 | 1M, 1T | GE | 3600 | 52.0 | 0.5 | 4 | 366–11 | 46.5 | H |
| 25.0 | 38.0 | 61.1 | 2 | 90 | M | 1 | 300 | M | PC | 13.3 | 2400 | C | 1 | M | GE | 3600 | 50.0 | 0.5 | 4 | 124–6 | 43.0 | H |
| 24.8 | .... | 38.9 | 1 | 117 | M | 1 | 215 | M | PC | 12.5–14.5 | 2100 | .... | 4 | 3M, 1T | GE | 1800 | 80.0 | 1.0 | 5 | 263–6 | 60.0 | H |
| 27.6 | 18.1 | 90.0 | 2 | 107 | M | 2 | 197 | M | PC | 12.5 | 2050 | EP | 8 | 6M, 2T | GE | 1800 | 60.0 | 0.5 | 4 | 235.9 | 39.4 | A |
| | | | | | | | | | | | | | | | GE | 1800 | 60.0 | 0.5 | 4 | 235–9 | 39.4 | A |
| 30.7 | 7.1 | .... | 1 | 55 | M | 1 | 103 | M | UF (365) | 13.8 | 2460 | .... | 2 | 1M, 1T | WE | 3600 | 12.5 | 0.7 | 3 | 174–35 | 12.5 | A |
| 16.9 | 9.8 | 42.4 | 2 | 52 | M | 2 | 89 | M | PC,O | 15.0–18.5 | 2600 | EP | 3 | 2M, 1T | GE | 3600 | 25.0 | 0.5 | 3 | 95–11 | 25.0 | H |
| 15.5 | 8.6 | 61.2 | 2 | 62 | M | 2 | 120 | M | PC | 11.0 | 1900 | EP | 5 | 3M, 2T | AC | 3600 | 40.0 | 0.7 | 4 | 185–5 | 38.0 | H |
| | | | | | | | | | | | | | | | AC | 3600 | 40.0 | 0.7 | 4 | 185–5 | 38.0 | H |
| 27.1 | 2.3 | 5.8 | 1 | 43 | M | 1 | 75 | M | SS (290) | 10.6 | 2200 | .... | 2 | T | WE | 3600 | 15.0 | 0.5 | 5 | 215 | 13.8 | A |
| ..... | .... | 44.2 | 1 | 96 | M | 1 | 218 | M | PC | 11.9 | 2200 | C | 3 | T | WE | 3600 | 50.0 | 1.0 | 6 | 270–2 | 41.0 | H |
| 26.0 | .... | 22.0 | 2 | 29 | M | 2 | 56 | M | G | 1.1 | ..... | .... | 2 | 1M, 1T | AC | 3600 | 15.0 | 0.7 | 4 | 218–7 | 16.9 | A |
| 25.6 | 13.8 | 51.6 | 2 | 79 | M | 2 | 152 | M | PC | 14.3 | 2300 | EP | 3 | 2M, 1T | GE | 1800 | 50.0 | 0.5 | 4 | 202–7 | 41.0 | A |
| 25.6 | 13.8 | 51.6 | 2 | 79 | M | 2 | 152 | M | PC | 14.3 | 2300 | EP | 3 | 2M, 1T | GE | 1800 | 50.0 | 0.5 | 4 | 202–7 | 41.0 | A |
| ..... | 3.8 | 42.2 | 1 | 85 | M | 1 | 148 | M | PC | 10.6 | 2050 | .... | 3 | 2M, 1T | GE | 1800 | 50.0 | 1.0 | 4 | 220–10 | 40.8 | A |
| ..... | 20.8 | .... | 1 | 77 | M | 1 | 140 | M | PC | 13.6 | 2450 | EP | 2 | 1M, 1T | GE | 3600 | 15.0 | 0.5 | 1 | 14.8 | 10.3 | A |
| | | | | | | | | | | | | | | | AC | .... | 25.0 | .... | .. | ..... | .... | .. |
| ..... | .... | .... | .... | .... | .... | .... | .... | .... | ..... | ..... | ..... | .... | .... | ..... | AC | .... | 25.0 | .... | .. | ..... | .... | .. |
| 25.9 | .... | 4.9 | 1 | 24 | T | 1 | 44 | T | G | 1.0 | ..... | .... | 1 | D | GE | 3600 | 1.5 | 16.5 | .. | ..... | .... | A |
| 22.6 | .... | 40.4 | 2 | 50 | M | 2 | 90 | M | PC,O | 10.1 | 1900 | C | 2 | 1-M,1-T | GE | 3600 | 15.0 | 0.5 | 5 | 200–11 | 18.0 | A |
| ..... | .... | .... | .... | .... | .... | .... | .... | .... | ..... | ..... | ..... | .... | .... | ..... | GE | 3600 | 5.0 | 215.0 | .. | ..... | .... | A |
| 21.6 | .... | 28.8 | 1 | 51 | M | 1 | 80 | M | PC | 11.5 | 2100 | .... | 2 | 1M, 1T | AC | 3600 | 25.0 | 1.0 | 4 | 221–10 | 28.0 | A |
| 21.6 | .... | 28.8 | 1 | 51 | M | 1 | 80 | M | PC | 11.5 | 2100 | .... | 2 | 1M, 1T | AC | 3600 | 25.0 | 1.0 | 4 | 221–10 | 28.0 | A |
| ..... | .... | .... | .... | .... | .... | .... | .... | .... | ..... | ..... | ..... | .... | .... | ..... | AC | 3600 | 30.0 | 1.4 | 4 | 206–6 | 24.0 | H |
| 24.2 | .... | 14.2 | 1 | 47 | M | 1 | 88 | M | PC | 14.2 | 2575 | EP | 3 | 2M, 1T | GE | 3600 | 25.0 | 0.5 | 4 | 265–12 | 21.5 | H |
| 20.9 | .... | 12.0 | 1 | 47 | D | 1 | 97 | M | PC,O | 6.5–18.0 | 19–2500 | .... | 1 | T | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | 2.0 | 13.0 | 1 | .... | M | 1 | .... | M | CG (316) | 6.6 | 2200 | .... | 2 | 1M, 1T | AC | 3600 | 10.0 | 0.7 | 3 | 195–36 | 8.1 | A |
| 25.7 | .... | 10.3 | 1 | 41 | T | 1 | 78 | T | O | ..... | ..... | .... | 1 | M | GE | 3600 | 3.5 | 175.0 | .. | ..... | .... | A |
| 34.0 | 6.0 | .... | 1 | 32 | M | 1 | 52 | M | UF (203) | 14.5 | 2600 | EP | 2 | T | WE | 3600 | 15.0 | 0.7 | 3 | 74–9 | 12.0 | A |
| 32.7 | 6.0 | .... | 1 | 32 | M | 1 | 52 | M | UF (203) | 14.5 | 2350 | .... | 2 | 1M, 1D | WE | 3600 | 7.5 | 0.7 | 3 | 122–12 | 8.0 | A |
| 30.6 | .... | 25.9 | 1 | 48 | M | 1 | 85 | M | O | 18.5 | ..... | .... | 3 | M | WE | 3600 | 15.0 | 0.5 | 4 | 147–8 | 14.0 | A |
| 27.4 | 13.7 | 55.0 | 2 | 70 | M | 2 | 110 | M | PC | 10.0 | 2100 | .... | 4 | M | GE | 1800 | 105.0 | 1.0 | 4 | 174–6 | 90.0 | A |
| 24.0 | .... | 80.0 | 1 | 225 | M | 1 | 385 | M | PC | 13.5–14.0 | 22–2700 | .... | 1 | M | GE | 1800 | 60.0 | 1.0 | 5 | ..... | 62.3 | A |
| 26.2 | 7.3 | 15.8 | 2 | 68 | M | 2 | 125 | M | UF (730) | 13.0 | 2200 | F | 1 | M | WE | 1800 | 60.0 | 0.7 | 4 | 155–6 | 55.0 | H |
| 19.1 | 5.0 | .... | 1 | 48 | M | 1 | 112 | M | PC | 14.1 | 2300 | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| 41.6 | .... | 3.4 | 1 | .... | M | 1 | .... | M | G | 1.0 | ..... | .... | 2 | 1M, 1T | WE | 3600 | 5.0 | 1.0 | 2 | 150–30 | 6.0 | A |
| 30.4 | .... | 4.4 | 1 | 18 | M | 1 | 33 | M | G, O | 0.9 | ..... | .... | 2 | 1M, 1T | AC | 3600 | 3.0 | 0.7 | 2 | 100–17 | 3.0 | A |
| ..... | ..... | 4.4 | 1 | 19 | M | 1 | 36 | M | G, O | 1.0 | ..... | .... | 2 | 1M, 1T | WE | 3600 | 3.0 | 0.7 | 2 | 100–17 | 3.5 | A |
| 36.0 | 5.3 | .... | 1 | 60 | M | 1 | 104 | M | UF (294) | 11.8 | 2100 | .... | 3 | 2M, 1T | AC | 3600 | 10.0 | 0.5 | 4 | 146–9 | 6.3 | A |
| 33.0 | 5.2 | .... | 1 | 56 | M | 1 | 88 | M | UF (230) | 13.8 | 2500 | .... | 3 | 2M, 1T | WE | 3600 | 7.5 | 0.5 | 4 | 198–6 | 6.4 | A |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | GE | 1800 | 20.0 | 1.0 | 3 | 40–6 | 28.5 | A |
| 12.5 | 1.3 | .... | 1 | 20 | M | 1 | 30 | M | G, O | 1.1 | ..... | .... | 2 | SP, M | GE | 3600 | 2.5 | 1.0 | 2 | 28–12 | 2.8 | A |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | GE | 3600 | 37.5 | 0.7 | 4 | 164–5 | 30.0 | H |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | WE | 3600 | 1.5 | 1.0 | 3 | ..... | 2.5 | A |
| ..... | 5.6 | .... | 1 | 30 | M | 1 | 70 | M | UF (318) | 10.6 | 2200 | .... | 3 | 2M, 1T | GE | 3600 | 7.5 | 0.5 | 4 | 93–4 | 8.8 | A |
| 35.0 | .... | .... | ..... | ..... | ..... | ..... | ..... | ..... | UF (267) | 14.2 | 2575 | .... | 1 | T | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | .... | 10.5 | 1 | 30 | M | 1 | 50 | M | G | 1.0 | ..... | .... | 3 | 2M, 1SP | GE | 3600 | 7.5 | 0.5 | 3 | 123–7 | 8.5 | A |
| 27.0 | .... | 11.8 | 1 | 62 | M | 1 | 92 | M | PC | 13.3 | ..... | .... | .... | ..... | ..... | ..... | ..... | ..... | .. | ..... | .... | .. |
| 46.5 | .... | 16.8 | 1 | 117 | M | 1 | 66 | T | PC | 10.6 | 2000 | C | .... | ..... | ..... | ..... | ..... | ..... | .. | ..... | .... | .. |
| 34.6 | .... | .... | .... | .... | .... | .... | .... | .... | CG (150) | 10.5 | 2400 | .... | .... | ..... | ..... | ..... | ..... | ..... | .. | ..... | .... | .. |
| ..... | .... | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | GE | 1800 | 35.0 | 0.7 | 3 | 121–7 | 35.0 | A |
| ..... | .... | .... | 1 | .... | M | .... | .... | .... | CG (133) | 13.2 | 2100 | .... | .... | ..... | ..... | ..... | ..... | ..... | .. | ..... | .... | .. |
| 37.0 | 2.2 | .... | 1 | 26 | M | 1 | 44 | M | UF (160) | 14.6 | 2810 | C | .... | ..... | ..... | ..... | ..... | ..... | .. | ..... | .... | .. |
| 21.5 | 4.0 | .... | 1 | 31 | M | 1 | 62 | M | PC | 13.4 | 2400 | .... | .... | ..... | ..... | ..... | ..... | ..... | .. | ..... | .... | .. |
| 41.5 | .... | .... | 1 | .... | M | 1 | .... | M | G,O | 1.0 | ..... | .... | 1 | T | ..... | ..... | ..... | ..... | .. | ..... | .... | .. |
| 20.8 | .... | .... | 1 | 25 | T | .... | .... | .... | O | 17.3 | ..... | .... | 1 | M | ..... | ..... | ..... | ..... | .. | ..... | .... | .. |

P —Precipitator
PC —Pulverized coal
PCk —Pulverized coke
PP —Pulverized pitch
RC —R D Cole Mfg Co
RG —Refinery gas
RH —Rice hulls
RS —Riley Stoker Corp
S —Sludge
SB —Springfield Boiler Co
SK —Skinner Engine Co
SP —Steam pump
SS —Spreader stoker
ST —Slag tap
T —Turbine drive
TE —Terry Steam Turbine Co
TG —Traveling-grate stoker
UF —Underfeed stoker
UI —Union Iron Works
VI —Vilter Mfg Co
WB —Wm Bros Boiler & Mfg Co
WC —Water-cooled stokers
WE —Westinghouse Elec & Mfg Co
WG —Waste gas
WI —Wickes Boiler Co
WW —Wood waste
X —Waterwall heating surface included in boiler surface
a —Dry basis
aa —Mixed-pressure turbine
† —Design, now operating at lower pressure
†† —One reheat boiler of lower capacity
‡ —Another unit on order for operation in 1942 or later

# Typical Industrials Above 200 Lb Installed

Compiled by L N Rowley,
*Associate Editor*

POWER, September, 1940
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| Company | Location | Consulting Engineers | First Operation Now Units | Pressure, Lb | BOILERS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Steam Temp, F | Number | Capacity Each, 1000 Lb per Hr | Manufacturer | Boiler Surface, 1000 Sq Ft | Waterwall Surface 1000 Sq Ft | Furnace Volume, 1000 Cu Ft | Stoker Duties |
| **500 LB AND ABOVE** | | | | | | | | | | | | |
| Kimberly Clark Corp | Kimberly, Wis | | ..... | 900 | 750 | 1 | 170 | BW | 12.3 | 2.1 | 6.9 | DB |
| Columbia Chemical Div | Barberton, Ohio | | 1-40 | 860 | 750 | 1 | 150 | BW | 15.1 | 2.2 | 8.7 | ... |
| Weirton Steel Co | Weirton, W. Va | | 1-41 | 825 | 820 | 1 | 400 | BW | 20.5 | 4.0 | 16.9 | ST |
| Youngstown Sheet & Tube Co | Indiana Harbor, Ind | United Engrs & Constr | ..... | 825 | 750 | 2 | 150 | BW | 13.8 | X | .... | ... |
| Albermarle Paper Mfg Co | Richmond, Va | | 9-40 | 750 | 750 | 1 | 70 | CE | 6.7 | 1.6 | 3.6 | DB |
| Textile Machine Co | Reading, Pa | | 9-40 | 710† | 700 | 1 | 100 | BD | 3.5 | 2.7 | 4.8 | DB |
| The Barrett Co | Philadelphia, Pa | | 10-40 | 708† | 750 | 1 | 175 | BD | 3.9 | 5.0 | 8.4 | DB |
| Bush Terminal Bldgs Co | Brooklyn, N. Y | | 1-39 | 700† | 700 | 1 | 120 | BD | 3.8 | 2.6 | 5.3 | DB |
| Norton Co | Worcester, Mass | F J Sill | 4-40 | 700 | 750 | 2 | 50 | RS | 5.1 | 1.6 | 2.7 | DB |
| Shell Oil Co | Wood River, Ill | | 1-40 | 700† | 750 | 1 | 125 | RS | 10.1 | 4.5 | 8.2 | DB |
| Humble Oil & Refg Co | Baytown, Texas | | ..... | 675 | 740 | 1 | 350 | RS | 22.5 | 9.0 | 21.3 | DB |
| Celluloid Corp | Newark, N. J | | ..... | 650 | 650 | 1 | 60 | CE | 5.3 | 1.9 | 3.2 | DB |
| Dunn Sulphite Paper Co | Port Huron, Mich | Burns & Roe | 12-39 | 650 | 725 | 1 | 40 | CE | 3.9 | 1.6 | .... | DB |
| Southland Paper Mills | Lufkin, Texas | Geo F Hardy | ..... | 650 | 750 | 3 | 76 | FW | 7.7 | 1.3 | 3.5 | DB |
| Tidewater Assoc Oil Co | Bayonne, N. J | | 8-40 | 650 | 750 | 2 | 100 | BW | 9.5 | 1.7 | .... | ... |
| The Texas Co | Port Arthur, Texas | Jackson & Moreland | 9-39 | 625 | 700 | 3 | 300 | FW | 15.4 | 2.2 | 10.5 | DB |
| Barber Asphalt Corp | Barber, N. J | | ..... | 600 | 700 | 2 | 30 | CE | 3.9 | 0.5 | 1.9 | DB |
| Container Corp of America | Circleville, Ohio | H M Wilson Co | 1-40 | 600† | 640 | 1 | 85 | CE | 9.0 | 1.0 | 3.7 | DB |
| Henry Disston & Sons Co | Philadelphia, Pa | H M Wilson Co | ..... | 600 | 660 | 3 | 75 | RS | 8.4 | 2.4 | 4.8 | DB |
| E I du Pont de Nemours | Seaford, Del | | 11-39 | 600 | 710 | 3 | 120 | CE | 7.8 | 2.6 | .... | DB |
| West Va. Pulp & Paper Co | Covington, Va | | 9-40 | 600 | 700 | .. | ... | ... | ... | ... | ... | ... |
| West Va. Pulp & Paper Co | Mechanicsville, N. Y | | 12-40 | 600 | 720 | 2 | 175 | FW | 13.6 | 1.8 | 15.1 | DB |
| U. S. Gypsum Co | Jersey City, N. J | | 3-40 | 600 | 750 | 1 | 30 | RS | 2.5 | 0.8 | 1.6 | ... |
| American Viscose Corp | Nitro, W. Va | H A Kuljian & Co | 12-40 | 585 | 750 | 2 | 80 | RS | 8.7 | 2.8 | 5.0 | DB |
| Andrew Jergens, Inc | Bellville, N. J | A M Kinney Inc | 11-40 | 525 | 750 | 1 | 56 | RS | 5.8 | 1.6 | 2.7 | DB |
| Kimberly Clark Corp | Niagara, Wis | | 3-40 | 510 | 675 | 2 | 90 | CE | 7.1 | 2.4 | 5.3 | DB |
| Carnegie-Illinois Steel Corp | Rankin, Pa | Stone & Webster | 11-40 | 500 | 750 | 1 | 450 | RS | 32.5 | 12.8 | 28.0 | DB |
| E I du Pont de Nemours | Belle, W. Va | | 8-40 | 500 | 750 | 2 | 150 | BW | 9.3 | 2.5 | .... | DB |
| **400 TO 499 LB** | | | | | | | | | | | | |
| Acadia Coal Co | Stellarton, N. S | | 12-39 | 480 | 750 | 1 | 65 | CE | 7.7 | 2.0 | 4.3 | DB |
| Brightwater Paper Co | Adams, Mass | H H Fales | 5-40 | 475 | 650 | 1 | 35 | CE | 4.1 | 1.4 | 1.8 | DB |
| Anheuser Busch Inc | St. Louis, Mo | | 1-40 | 465 | 590 | .. | ... | ... | ... | ... | ... | ... |
| Afga Ansco Div | Binghamton, N. Y | | 1-40 | 450 | 700 | 1 | 55 | RS | 5.9 | 1.9 | 3.0 | DB |
| American Coating Mills, Inc | Elkhart, Ind | | 9-40 | 450 | 600 | 1 | 100 | BW | 11.7 | 0.8 | 4.4 | ... |
| Walter Baker & Co | Dorchester, Mass | | 7-40 | 450† | ... | 1 | 40 | BW | 4.0 | X | 1.6 | ... |
| Castanea Paper Co | Johnsonburg, Pa | J E Greenawalt | ..... | 450† | ... | 1 | 30 | RS | .... | .... | .... | ... |
| Container Corp of America | Chicago, Ill | H M Wilson Co | ..... | 450† | 610 | 1 | 85 | RS | 9.0 | 1.4 | 3.3 | ... |
| Flintkote Co | Los Angeles, Calif | | 7-39 | 450 | 460 | 1 | 60 | BW | 4.7 | X | 1.8 | DB |
| Robert Gair Co | Piermont, N. Y | | 10-40 | 450 | 600 | 1 | 150 | FW | 12.7 | 1.3 | .... | ... |
| General Analine & Film Corp | Grasselli, N. J | | 3-40 | 450 | 700 | 1 | 40 | RS | 3.8 | 0.9 | 2.0 | DB |
| Heyden Chemical Corp | Fords, N. J | Orrok, Myers & Shoudy | 3-40 | 450† | 650 | 1 | 30 | RS | 3.4 | 0.9 | 2.0 | ... |
| Huron Milling Co | Harbor Beach, Mich | J I Bennett | ..... | 450 | 600 | 1 | 60 | WI | 6.1 | 0.6 | 4.0 | ... |
| Mathews Cotton Mills | Greenwood, S. C | George Hill | 2-40 | 450 | 720 | 1 | 75 | BW | 8.0 | X | 3.2 | DB |
| Ottawa Silica Co | Ottawa, Ill | Larramore & Douglass | ..... | 450 | 600 | 3 | 35 | WB | .... | .... | .... | ... |
| Pan American Refining Corp | Texas City, Texas | | ..... | 450 | 700 | 1 | 104 | CE | 13.6 | .... | 5.8 | ... |
| Rath Packing Co | Waterloo, Iowa | | ..... | 450 | 675 | 1 | 75 | CE | 7.9 | 0.6 | .... | ... |
| Republic Rubber Co | Youngstown, Ohio | R R Jones | ..... | 450 | ... | .. | ... | ... | ... | ... | ... | ... |
| Clinton Co | Clinton, Iowa | Sargent & Lundy | 8-40 | 450 | 550 | 3 | 100 | BW | 10.7 | 0.9 | 4.4 | ... |
| St Croix Paper Co | Woodland, Me | Geo F Hardy | 9-40 | 450 | 715 | 1 | 125 | RS | 11.3 | 3.3 | 7.6 | ST |
| Sylvania Industrial Corp | Fredericksburg, Va | | ..... | 450 | 600 | 1 | 120 | EM | 10.3 | 0.5 | 4.1 | ... |
| Proximity Mfg Co | Greensboro, N. C | J E Sirrine & Co | 6-40 | 450 | 710 | 1 | 150 | CE | 11.5 | 3.0 | 8.6 | DB |
| Ecusta Paper Corp | Pisgah Forest, N. C | J E Sirrine & Co | ..... | 425 | 725 | 2 | 28 | CE | 4.4 | .... | .... | ... |
| Jackson Mills | Wellford, S. C | George Hill | 8-40 | 425† | 720 | 1 | 30 | BW | 4.2 | X | 1.6 | DB |
| Jackson Mills | Iva, S. C | George Hill | 1-39 | 425 | 720 | 1 | 30 | BW | 4.2 | X | .... | DB |
| Lehigh Portland Cement Co | Union Bridge, Md | | 6-39 | 425 | 725 | 2 | ... | BW | 9.8 | .... | .... | ... |
| Lehigh Portland Cement Co | Alsen, N. Y | | 3-40 | 425 | 725 | 2 | ... | BW | 9.8 | .... | .... | ... |
| Masonite Corp | Laurel, Miss | | ..... | 425 | Sat | 1 | 50 | RS | 5.7 | 1.1 | 2.4 | ... |
| N. C. Finishing Co | Yadkin, N. C | J E Sirrine & Co | 9-39 | 425 | 580 | 1 | 75 | CE | 6.6 | 1.5 | .... | DB |
| Socony Vacuum Oil Co | Paulsboro, N. J | | 4-40 | 405 | 550 | .. | ... | ... | ... | ... | ... | ... |
| John Morrell & Co | Ottumwa, Ia | Helmick, Edeskuty & Lutz | 1941 | 410 | 675 | 1 | 100 | BW | 9.5 | 3.1 | 9.3 | DB |
| American Viscose Corp | Meadville, Pa | H A Kuljian & Co | 7-40 | 400 | 700 | 1 | 150 | BW | 10.0 | 2.6 | 8.3 | DB |
| Champion-Intn't'l Co | Lawrence, Mass | Charles T Main | ..... | 400 | Sat | 1 | 6 | EM | 1.8 | 0.4 | 0.7 | ... |
| Colgate-Palmolive-Peet Co | Jeffersonville, Ind | J G White | 1-39 | 400 | 585 | 1 | 50 | CE | 5.6 | 1.0 | 2.1 | DB |
| Congoleum-Nairn Inc | Kearny, N. J | Jackson & Moreland | 5-39 | 400 | 715 | 2 | 39 | CE | 4.0 | 1.5 | .... | DB |
| E I du Pont de Nemours | Richmond, Va | | ..... | 400 | 680 | .. | ... | ... | ... | ... | ... | ... |
| Hartford Rayon Co | Rocky Hill, Conn | Orrok, Myers & Shoudy | 6-40 | 400 | 600 | 1 | 40 | BW | 3.7 | X | 1.4 | ... |
| The Hobart Mfg Co | Troy, Ohio | W I Barrows | 10-40 | 400† | 600 | 1 | 50 | SB | 4.7 | 0.6 | 1.5 | ... |
| Utica Knitting Co | Utica, N. Y | Gibbs & Hill | 12-40 | 400 | 540 | 1 | 50 | CE | 5.9 | 0.6 | .... | ... |
| **BELOW 400 LB** | | | | | | | | | | | | |
| Nat'l Paper Products Co | Pt. Townsend, Wash | | 9-40 | 375 | 425 | 1 | 50 | BW | 6.4 | 2.0 | 4.8 | ST |
| Atlas Powder Co | Reynolds, Pa | | ..... | 350 | Sat | 1 | 40 | CE | 5.6 | 0.3 | .... | ... |
| Paper Service Co | Lockland, Ohio | | ..... | 350 | Sat | 1 | 15 | CE | 2.2 | .... | .... | ... |
| Krey Packing Co | St. Louis, Mo | | ..... | 325 | 430 | 2 | 40 | EC | 4.0 | 0.1 | 1.5 | ... |
| Atlantic Gelatin Co | Woburn, Mass | | 7-40 | 300† | Sat | 2 | 65 | CE | 6.3 | 1.4 | 2.7 | ... |
| Cannon Mills Co | Concord, N. C | J E Sirrine Co | 10-40 | 300 | Sat | 1 | 60 | CE | 6.2 | 2.1 | .... | DB |
| Hercules Powder Co | Hattiesburgh, Miss | | 7-39 | 300† | Sat | 2 | 75 | HV | 7.1 | .... | 3.8 | ... |
| Swift Canadian Co, Ltd | St. Boniface, Man | | ..... | 300 | Sat | 2 | 30 | FW | 3.0 | .... | 2.3 | ... |
| Manitoba Sugar Co, Ltd | Fort Garry, Man | | 10-40 | 280 | 614 | 2 | 45 | FW | 5.9 | .... | 2.0 | ... |
| Ohio Salt Co | Rittman, Ohio | H M Wilson Co | 8-40 | 277† | Sat | 1 | 120 | RS | 10.8 | 1.4 | 3.8 | ... |
| American Potash & Chem Co | Trona, Calif | | 10-40 | 275 | 570 | 1 | 217 | BW | 16.3 | 1.1 | 7.0 | ... |
| American Woolen Co | Fitchburg, Mass | | 9-40 | 275 | 525 | 2 | 30 | CE | 3.8 | .... | 1.5 | ... |
| Bethlehem Steel Co | Quincy, Mass | United Engrs & Const | ..... | 275 | Sat | 3 | 50 | CE | 5.6 | 1.3 | 2.3 | ... |
| Naugatuck Chemical Div | Naugatuck, Conn | Lockwood Greene Engrs | 11-40 | 275 | 414 | 3 | 60 | BW | 5.7 | X | 2.2 | ... |
| J S Abercrombie Co | Sweeny, Texas | | 9-39 | 250 | Sat | 1 | 40 | RS | 4.3 | 0.9 | 2.0 | ... |

*AC* —Allis-Chalmers Mfg Co
*AS* —Acid sludge
*B* —Bagasse
*BA* —Bark
*BD* —Badenhausen
*BFG* —Blast-furnace gas
*BI* —The Bigelow Co
*BL* —Black liquor
*BM* —Bellis & Morcom
*BW* —Babcock & Wilcox Co
*C* —Coal, bituminous
*CA* —Coal, anthracite
*CE* —Combustion Engineering Co
*CF* —Compensating-feed stoker
*CG* —Chain-grate stoker
*COG* —Coke-oven gas
*CY* —Cyclone
*D* —Dual drive
*DB* —Dry bottom
*EC* —Erie City Iron Works
*EK* —E Keeler Co
*EL* —Elliott Co
*EM* —Edge Moor Iron Works
*EP* —Electrostatic precipitator
*F* —Underfeed stoker
*FW* —Foster Wheeler Corp
*Fu* —Future installation
*G* —Gas
*GE* —General Electric Co
*HS* —Hofft stoker
*M* —Motor drive
*MI* —Murray Iron Works

# or Under Construction Since January, 1939

| Heat Liberation, 1000 Btu per Cu Ft | Economizer Surface per Boiler, 1000 Sq Ft | Air Heater Surface per Boiler, 1000 Sq Ft | FD FANS | | | ID FANS | | | Firing | FUEL | | FEED PUMPS | | TURBINES | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Number per Boiler | Capacity Each, 1000 CFM | Drive | Number per Boiler | Capacity Each, 1000 CFM | Drive | | Heating Value, 1000 Btu per Lb | Ash Fusion Temp, F | Number | Drive | Manufacturer | Speed, RPM | Capacity, 1000 Kw | Backpressure, Lb Abs | No. of Bleed Points | Bleed Press., Lb Abs | Condenser Surface 1000 Sq Ft |
| 34.1 | .. | 12.7 | 1 | 45 | M | 1 | 100 | T | PC | 15.0* | 2100 | 2 | 1M, 1T | AC | 3600 | 5.0 | 190.0 | .. | .... | .... |
| 27.9 | 3.8 | 12.2 | 1 | 80 | T | 1 | 133 | T | WC (404) | 12.2 | 2100 | 2 | T | WE | 3600 | 5.0 | 155.0 | 1 | 415 | .... |
| 31.1 | .. | 49.5 | 1 | 113 | T | 1 | 228 | T | PC, BFG, COG | 12.5 | 2150 | 1 | T | AC | .... | 10.0 | 210.0 | .. | .... | .... |
| .. | .. | .. | 1 | .. | T | 1 | .. | T | PC | 11.0 | 2100 | .. | ..... | WE | 3600 | 10.0 | 200.0 | .. | .... | .... |
| .. | .. | 4.8 | 1 | 22 | M | 1 | 45 | M | PC | 14.7 | 2800 | 2 | 1M, 1T | GE | 3600 | 5.0 | 1.0 | 2 | 240–65 | 3.6 |
| 25.0 | 2.9 | 12.6 | 1 | 32 | M | 1 | 52 | M | PC | 13.8 | 2200 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 25.0 | 4.8 | 14.0 | 1 | 53 | D | 1 | 100 | D | O, PC, PP | 18.0 | .... | 1 | T | ..... | .... | .... | .... | .. | .... | .... |
| 30.0 | 3.6 | 16.5 | 1 | 40 | T | 1 | 72 | T | O, PC | 18.0 | .... | 2 | T | ..... | .... | .... | .... | .. | .... | .... |
| 25.0 | 1.0 | 3.8 | 1 | 75 | M | 1 | 82 | M | PC | 14.0 | 2300 | 2 | M | GE | 3600 | 2.5 | 18.0 | 1 | 140 | .... |
| 20.6 | .. | 15.0 | 1 | 35 | T | 1 | 95 | T | PC, PCk, G, O | 11.5 | 1900 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 22.3 | 13.6 | .. | 1 | 93 | D | 2 | 86 | D | G, AS, O | .... | .... | .. | ..... | GE | 3600 | 7.5 | 155.0 | .. | .... | .... |
| 24.4 | .. | 5.8 | 1 | 18 | M | 1 | 34 | M | PC | 14.4 | 2700 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | 3.8 | 1 | 14 | M | 1 | 29 | M | PC, O | 14.0 | 2500 | 2 | 1M, 1T | AC | 3600 | 2.0 | 0.7 | 1 | 50 | 2.1 |
| 31.8 | .. | 3.4 | 1 | 24 | M | 1 | 53 | M | G | .... | .... | 2 | 1M, 1T | 2-GE | 3600 | 6.0 | 1.0 | 2 | 140–50 | 6.6 |
| 27.8 | .. | .. | 1 | 51 | T | 1 | 100 | T | O, G | 18.5 | .... | 2 | 1M, 1T | GE | 3600 | 3.4 | 165.0 | .. | .... | .... |
| 37.3 | .. | 20.1 | 2 | 43 | M | 2 | 74 | M | RG, O, PCk | 21.3 | .... | 3 | M, T, D | 2-WE | 3600 | 7.5 | 175.0 | 1-Fu | 190 | .... |
| | | | | | | | | | | | | | | 1-WE | 3600 | 7.5 | .... | 2 | 190–25 | 10.8 |
| 23.8 | .. | .. | .. | .. | .. | 1 | 30 | M | RG, O | .... | .... | 2 | 1M, 1T | WE | 3600 | 1.3 | 165.0 | .. | .... | .... |
| .. | Fu | .. | 1 | 40 | M | .. | .. | .. | UF (232) | 13.8 | 2500 | 2 | M | ..... | .... | .... | .... | .. | .... | .... |
| 21.2 | .. | 7.2 | 1 | 32 | M | 1 | 55 | M | PC, O | 14.0 | 2300 | 4 | 3T, 1M | ..... | 3600 | 4.0 | 1.0 | 1 | 125 | 4.0 |
| 23.0 | 2.0 | 9.1 | 1 | 40 | T | 1 | 66 | T | O | 18.4 | .... | 4 | T | 2-WE | 3600 | 7.5 | .... | 2 | 165–35 | 7.1 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | WE | 3600 | 10.0 | 1.0 | 1 | 30 | 11.0 |
| 16.9 | 8.5 | 4.4 | .. | .. | .. | 1 | 134 | D | PCA | 11.9 | 3000 | 3 | T | WE | 3600 | 4.0 | 1.0 | 2 | 165–45 | 5.0 |
| 27.5 | 0.7 | .. | .. | .. | .. | 1 | 20 | M | O | 18.8 | .... | 2 | M | WE | 3600 | 1.0 | .... | 2 | 115–30 | 0.7 |
| 22.0 | .. | 7.9 | 1 | 30 | M | 1 | 65 | M | PC | 12.5 | 2200 | 3 | 2T, 1M | WE | 3600 | 2.5 | 30.0 | 1 | 210 | .... |
| 26.2 | .. | 5.8 | 1 | .. | M | 1 | .. | M | O, PC | .... | .... | 2 | M | ..... | .... | .... | .... | .. | .... | .... |
| 22.0 | .. | 11.8 | 1 | 43 | M | 1 | 80 | T | PC | 15.0* | 2100 | 2 | 1M, 1T | WE | 3600 | 2.0 | 140.0 | .. | .... | .... |
| 22.3 | 9.2 | 38.5 | 2 | 74 | M | 2 | 244 | M | BFG, PC | .... | .... | 3 | T | AC | 1500 | 32.0 | 0.9 | 3 | 188–9 | 35.0 |
| 30.0 | .. | .. | 1 | 53 | M | 1 | 93 | M | PC | 13.6 | 2250 | 1 | T | ..... | .... | .... | .... | .. | .... | .... |
| 19.0 | .. | 5.9 | 1 | 18 | M | 1 | 36 | M | PC | 10.5 | .... | 2 | 1M, 1T | ..... | .... | .... | .... | .. | .... | .... |
| 26.4 | .. | 3.5 | 1 | 10 | M | 1 | 20 | M | PC | 14.5 | 2550 | 2 | 1M, 1T | GE | 3600 | 0.8 | 25.0 | 1 | 75 | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | GE** | 3600 | 2.5 | .... | 1 | 21 | 6.6 |
| 29.6 | .. | 5.6 | 1 | 16 | M | 1 | 30 | M | PC | 14.0 | 2400 | 2 | 1M, 1T | ..... | .... | .... | .... | .. | .... | .... |
| 33.4 | .. | .. | 1 | 44 | D | 1 | 80 | D | CG (304) | 10.9 | 2000 | 2 | 1T, 1M | ..... | .... | .... | .... | .. | .... | .... |
| 32.4 | .. | .. | 1 | 13 | M | .. | .. | .. | O | 18.4 | .... | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | 1 | 16 | M | 1 | 27 | M | BL | .... | .... | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | Fu | .. | 1 | 40 | M | Fu | .. | .. | TG (276) | 11.6 | .... | 2 | 1M, 1T | ..... | .... | .... | .... | .. | .... | .... |
| 37.1 | .. | 2.6 | 1 | 16 | M | 1 | 32 | M | O, G | 18.0 | .... | 1 | T | ..... | .... | .... | .... | .. | .... | .... |
| .. | 8.7 | 2.8 | 1 | .. | T | 1 | .. | T | PCA | .... | .... | 2 | T | WE | 3618 | 2.0 | 150.0 | .. | .... | .... |
| 26.3 | .. | 3.3 | 1 | .. | M | 1 | .. | M | O | 18.5 | .... | 3 | 2M, 1T | GE | 3600 | 2.0 | 1.5 | 2 | 110–20 | 1.5 |
| 19.4 | 0.9 | .. | 1 | 8 | M | .. | .. | .. | O | 18.5 | .... | 2 | T | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | 7.1 | 1 | 75 | M | 1 | 75 | M | SS (196) | 13.5 | .... | 2 | 1M, 1T | GE | 3600 | 1.0 | 150.0 | .. | .... | .... |
| 30.2 | .. | .. | 1 | 25 | M | .. | .. | .. | PC, O | 14.3 | 2650 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | 1 | .. | M | 1 | .. | M | SS (121) | .... | .... | 3 | 2M, 1T | 2-AC | .... | 1.3 | 1.0 | 1 | 165 | .... |
| 23.6 | .. | .. | 1 | 35 | M | 1 | 73 | M | G | 20.4 | .... | .. | ..... | WE | 3600 | 3.0 | 115.0 | .. | .... | .... |
| .. | 3.7 | .. | 1 | 40 | D | 1 | 70 | D | SS (280) | 11.8 | 2000 | 2 | 1M, 1T | GE | 3600 | 1.5 | 45.0 | 1 | 125 | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | 1 | T | GE | 3600 | 2.3 | .... | 2 | 150–3 | 2.6 |
| 30.0 | 2.3 | 5.6 | 1 | 40 | M | 1 | 70 | M | CG (326) | 11.0 | 2100 | 2 | T | AC | 3600 | 3.5 | 165.0 | .. | .... | .... |
| 22.8 | 6.0 | .. | 1 | 35 | M | 1 | 80 | M | PC | 12.5* | 2000 | 1 | M | ..... | .... | .... | .... | .. | .... | .... |
| 32.6 | 3.4 | .. | 1 | 50 | D | 1 | 79 | D | UF (262) | 14.7 | 2800 | 2 | T | WE | 3600 | 2.5 | 75.0 | .. | .... | .... |
| 23.5 | .. | 14.7 | 1 | 42 | M | 1 | 85 | M | PC | 13.8 | 2250 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 29.4 | .. | .. | 2 | 14 | M | .. | .. | .. | UF (91) | 13.9 | 2600 | 2 | 1M, 1T | GE | 3600 | 2.0 | 1.0 | 1 | 90 | 2.2 |
| 26.1 | .. | .. | 1 | .. | M | .. | .. | .. | PC | 14.1 | 2600 | 1 | T | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | 1 | .. | M | .. | .. | .. | PC | 14.4 | 2600 | 2 | 1M, 1T | AC | 3600 | 2.0 | 1.2 | 3 | 140–30 | 2.2 |
| .. | 5.3 | .. | .. | .. | .. | 1 | 46 | M | WG | .... | .... | 2 | 1M, 1T | GE | 3600 | 3.0 | 1.0 | 2-Fu | .... | 4.0 |
| .. | 5.3 | .. | .. | .. | .. | 1 | 46 | M | WG | .... | .... | 2 | 1M, 1T | GE | 3600 | 3.0 | 1.0 | 2-Fu | .... | 4.0 |
| 37.2 | .. | 3.3 | 1 | 77 | .. | 1 | 89 | .. | G | 21.3 | .... | 1 | SP | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | 8.7 | 1 | 24 | M | .. | .. | .. | PC | 14.8* | 2760 | 1 | T | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | GE | 3600 | 1.7 | 205.0 | .. | .... | .... |
| 14.9 | .. | 17.9 | 1 | 42 | D | 1 | 85 | D | PC | 9.5 | 1800 | .... | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 24.9 | .. | 13.7 | 1 | 57 | M | 1 | 110 | M | PC | 13.8 | 2400 | 1 | M | GE | 3600 | 5.0 | 1.0 | 1 | 190 | 8.9 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | BL | .... | .... | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 32.0 | 2.3 | .. | 1 | 25 | T | 1 | 40 | T | CG (187) | 11 0 | 2100 | 2 | T | GE | 3600 | 1.0 | 20 | 1 | 105 | .... |
| 29.7 | .. | 8.5 | 2 | 16 | T | 2 | 25 | T | PC, O | 14.5 | 2865 | 3 | 2T, 1M | 2-WE | 3600 | 1.0 | 20.0 | 1 | 120 | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | GE | 3600 | 2.4 | 45.0 | .. | .... | .... |
| .. | .. | 3.6 | 1 | 45 | M | 1 | 55 | M | O | 18.5 | .... | 2 | T | 1-TE | 3600 | 1.0 | 25.0 | .. | .... | .... |
| | | | | | | | | | | | | | | 2-TE | 3600 | 0.5 | 25.0 | .. | .... | .... |
| .. | .. | .. | 1 | 17 | T | .. | .. | .. | UF (124) | 13.7 | 2485 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 28.0 | 1.9 | .. | 1 | 24 | M | 1 | 40 | M | UF (139) | 13.6 | 2600 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | 2.4 | 6.2 | 1 | 90 | M | 1 | 120 | M | BL | 3.5 | .... | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | 1 | .. | D | .. | .. | .. | TG (160) | 11.0 | .... | 1 | T | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | 1 | 7 | M | .. | .. | .. | UF (42) | 13.5 | 2400 | 1 | M | ..... | .... | .... | .... | .. | .... | .... |
| 45.0 | .. | .. | 1 | 19 | M | .. | .. | .. | CG (126) | 11.0 | 1800 | 3 | 2T, 1M | EL | 3600 | 1.0 | 1.0 | 3 | 135– | 1.1 |
| 27.3 | .. | 4.4 | 1 | 16 | T | 1 | 29 | T | O | 18.0 | .... | 2 | T | ..... | .... | .... | .... | .. | .... | .... |
| 24.0 | .. | 4.2 | 1 | 17 | T | 1 | 34 | M | PC | 15 0 | 2200 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | 2 | 18 | M | .. | .. | .. | HS (150) | 8.8* | (ww) | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 47.5 | .. | .. | 1 | 15 | M | .. | .. | .. | CG (112) | 7.0 | 2300 | 2 | T | ..... | .... | .... | .... | .. | .... | .... |
| 33.4 | .. | 7.5 | 1 | .. | M | 1 | .. | M | TG (192) | 7.2 | 2200 | 2 | 1M, 1T | EL | 3600 | 1.5 | 50.0 | .. | .... | .... |
| 38.0 | 4.8 | .. | .. | .. | .. | 1 | 100 | M | TG (310) | 12.9 | 2050 | 1 | M | ..... | .... | .... | .... | .. | .... | .... |
| 34.5 | .. | 17.5 | 1 | 59 | M | 1 | 89 | M | O | 18.1 | .... | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | 1 | 18 | M | .. | .. | .. | O | 18.5 | .... | 2 | SP | WE | 3600 | 0.7 | 25.0 | .. | .... | .... |
| 25.0 | .. | .. | 1 | 18 | M | .. | .. | .. | O | 18.5 | .... | 3 | 2T, 1SP | ..... | .... | .... | .... | .. | .... | .... |
| 32.0 | .. | 1.8 | 1 | 19 | T | 1 | 37 | T | UF (135) | 14.0 | .... | 3 | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 27.3 | 0.9 | .. | 1 | .. | T | 1 | .. | T | G | .... | .... | 2 | T | ..... | .... | .... | .... | .. | .... | .... |

*MS* —Moore Steam Turbine Corp
*O* —Oil
*OF* —Overfeed stoker
*P* —Precipitator
*PC* —Pulverized coal
*RC* —Refinery gas
*RH* —Rice hulls
*RS* —Riley Stoker Corp
*S* —Sludge
*SB* —Springfield Boiler Co
*PCk* —Pulverised coke
*PP* —Pulverised pitch
*SP* —Steam pump
*SS* —Spreader stoker
*ST* —Slag tap
*T* —Turbine drive
*TE* —Terry Steam Turbine Co
*TG* —Traveling-grate stoker
*UF* —Underfeed stoker
*UI* —Union Iron Works
*WB* —Wm Bros Boiler & Mfg Co
*WC* —Water-cooled stoker
*WE* —Westinghouse Elec & Mfg Co
*WG* —Waste gas
*WI* —Wickes Boiler Co
*WW* —Wood waste
X —Waterwall heating surface included in boiler surface
* —Dry basis
** —Mixed-pressure turbine
† —Design, now operating at lower pressure

# Typical Industrials Above 200 lb

Compiled by S A Tucker and L N Rowley
*Associate Editors*

| Company | Location | Consulting Engineers | Yr Operation New Units | Pressure, Lb | BOILERS: Temp, F | Number | Capacity Each, 1000 Lb per Hr | Manufacturer | Heat Surface, 1000 Sq Ft | Waterwall Surface, 1000 Sq Ft | Furnace Volume, 1000 Cu Ft | Furnace Bottom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| American Optical Co. | Southbridge, Mass. | ..... | ..... | 250 | 500 | 1 | 85 | CE | 12.0 | .... | 5.5 | ... |
| Armstrong Tire & Rubber Co. | Natchez, Miss. | ..... | ..... | 250 | 406 | 1 | 17 | BI | 2.5 | .... | .... | ... |
| Barber Colman Co. | Rockford, Ill. | ..... | 6-40 | 250 | 500 | 1 | 50 | BW | 7.5 | 0.3 | ... | ... |
| C F B aun & Co. | Alhambra, Calif. | ..... | 7-40 | 250 | 406 | 1 | 9 | RS | 3.0 | .... | 0.8 | ... |
| Dryden Paper Co. Ltd. | Dryden, Ontario | ..... | ..... | 250 | 570 | 1 | 30 | CE | 4.0 | 0.4 | .... | ... |
| Erwin Cotton Mills | W Durham, N. C. | J E Sirrine & Co. | 10-40 | 250 | 500 | 2 | 33 | BW | 4.0 | 0.1 | .... | ... |
| Froedtert Grain & Malting Co. | Milwaukee, Wis. | Corwin, Behling | 8-40 | 250 | 498 | 2 | 45 | EC | 5.0 | 0.3 | 1.8 | ... |
| General Motors Corp. | Anderson, Ind. | ..... | 9-40 | 250 | 554 | 1 | 50 | RS | 6.4 | 1.3 | 3.1 | DB |
| Hercules Powder Co. | Hercules, Calif. | C C Moore | 6-39 | 250 | Sat | 1 | 32 | BW | 5.0 | .... | .... | ... |
| Murray Iron Works | Burlington, Iowa | ..... | 10-39 | 250 | Sat | 1 | 15 | MI | 2.3 | 0.2 | 0.6 | ... |
| Newark Stove Co. | Newark, Ohio | Peter F Loftus | 10-39 | 250 | Sat | 2 | 18 | BW | 2.8 | 0.2 | 0.8 | ... |
| New Bedford Rayon Co. | New Bedford, Mass. | Jenks & Ballou | 8-40 | 250 | Sat | 3 | 30 | BW | 3.1 | 0.6 | 1.4 | ... |
| Ohio Leather Co. | Girard, Ohio | F O Wallene | 1-40 | 250 | ... | 1 | 50 | EC | 7.8 | 0.4 | 2.1 | ... |
| Charles Sucher Packing Co. | Dayton, Ohio | Louis Kimmig | 8-40 | 250 | 250 | 2 | 30 | UI | 5.1 | .... | 1.6 | ... |
| Utica Willowvale Bleaching Co. | Chadwicks, N. Y. | Lockwood Greene Engrs. | 6-40 | 250 | Sat | 3 | 30 | EK | 4.0 | .... | 1.0 | ... |
| Wm Wrigley Jr Co. | Chicago, Ill. | Ewing Brooke | 7-39 | 250 | Sat | 1 | 36 | CE | 5.3 | 0.5 | 1.6 | ... |
| Refined Sugars & Syrups, Inc. | Yonkers, N. Y. | Suchar Process Corp. | 3-40 | 240 | 455 | 1 | 60 | RS | 5.4 | 1.6 | 3.0 | DB |
| Alabama Byproducts Corp. | Tarrant, Ala. | ..... | 1-40 | 225 | 487 | 1 | 65 | CE | 6.9 | 2.0 | .... | DB |
| Atlas Powder Co. | Stamford, Conn. | ..... | 2-40 | 225 | 500 | 1 | 70 | EM | 7.2 | 1.0 | 1.5 | ... |
| Erwin Cotton Mills | Cooleemee, N. C. | J E Sirrine & Co. | 6-40 | 225 | 600 | 2 | ... | BW | 5.0 | .... | .... | ... |
| Worcester Salt Co. | Silver Springs, N. Y. | ..... | 5-40 | 225 | 465 | 1 | 150 | RS | 12.8 | 4.0 | 7.9 | DB |
| Nevada Consol Copper Corp. | McGill, Nev. | ..... | ..... | 210 | 625 | 1 | 100 | RS | 14.9 | 1.4 | 5.6 | ... |
| Studebaker Corp. | South Bend, Ind. | ..... | 11-40 | 210 | 520 | 1 | 210 | FW | 18.8 | 8.6 | 9.7 | ... |

# Typical Municipal Plants Installed or

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ABOVE 400 LB** | | | | | | | | | | | | |
| City of Norwich | Norwich, Conn. | Arthur L Nelson | ..... | 725 | 750 | 1 | 75 | RS | 6.5 | 2.0 | 3.7 | DB |
| City of Burbank | Burbank, Calif. | Carl Heinze | 1-41 | 675 | 825 | 2 | 120 | BW | 8.9 | 1.3 | 4.5 | ... |
| Tri-State Power Cooperative | Genowa, Wis. | A Y Taylor Co. | ..... | 665 | 855 | 2 | 40 | RS | 3.4 | 1.8 | 2.2 | ST |
| City of Cleveland | Cleveland, Ohio | Peter F Loftus | ..... | 665 | 835 | 3 | 300 | FW | 20.6 | 2.6 | 14.5 | ST |
| City of Glendale | Glendale, Calif. | Hedrich, Heinze | 12-40 | 650 | 825 | 2 | 200 | CE | 12.4 | 2.6 | 7.5 | ... |
| City of Holland | Holland, Mich. | Giffels & Vallet | 6-40 | 600 | 825 | 2 | 112 | EM | 7.8 | 1.6 | 4.1 | ... |
| City of Lakeland | Lakeland, Fla. | Charles Larsen | 1-40 | 525 | 750 | 1 | 65 | BW | .... | .... | 6.8 | ... |
| Borough of Vineland | Vineland, N. J. | Schofield Engrg Co. | ..... | 450 | 750 | 1 | 96 | BW | 7.9 | 0.2 | 2.9 | ... |
| Mun Elec Pwr & Water Co. | Corbin, Ky. | Burns & McDonnell | 7-40 | 450 | 750 | 1 | 25 | EM | 4.4 | 0.3 | 1.3 | DB |
| City of Ames | Ames, Iowa | ..... | ..... | ... | 750 | .. | ... | .... | .... | .... | .... | ... |
| Water & Light Commission | Greenville, N. C. | W C Olsen | 1939 | 450 | 750 | 1 | 70 | CE | 8.0 | 1.7 | .... | DB |
| City of Worthington | Worthington, Minn. | R D Thomas | ..... | 450 | 750 | 1 | 60 | WB | 7.5 | .... | 2.5 | ... |
| Greenwood County | Greenwood, S. C. | George Hill | 8-40 | 450 | 725 | 1 | 80 | BW | 7.4 | 1.4 | 3.7 | DB |
| Department of Utilities | Provo, Utah | Uhlen Contr Co. | 4-40 | 450 | 725 | 2 | 25 | CE | 4.0 | 0.1 | .... | ... |
| Town of Braintree | Braintree, Mass. | Arthur L Nelson | 11-40 | 450 | 640 | .. | ... | .... | .... | .... | .... | ... |
| City of Grand Island | Grand Island, Neb. | Black & Veatch | 1-40 | 445 | 750 | 1 | 70 | BW | 6.8 | 1.2 | 4.0 | DB |
| City of Ottawa | Ottawa, Kan. | Black & Veatch | 3-40 | 440 | 750 | 2 | 45 | RS | 5.5 | 0.3 | 3.0 | ... |
| City of Owensboro | Owensboro, Ky. | Black & Veatch | 6-40 | 440 | 750 | 2 | 100 | BW | 11.0 | 1.1 | 7.5 | DB |
| City of Wellington | Wellington, Kan. | Black & Veatch | 2-40 | 425 | 750 | 2 | 40 | BW | 5.0 | 0.4 | 2.9 | ... |
| City of Alliance | Alliance, Neb. | Black & Veatch | 11-39 | 425 | 750 | 2 | 30 | EC | 4.7 | 0.2 | .... | ... |
| City of Larned | Larned, Kan. | Black & Veatch | 5-40 | 425 | 750 | 2 | 30 | BW | 4.0 | 0.2 | 2.1 | ... |
| City of Wyandotte | Wyandotte, Mich. | Smith & Hinchmann | 1-40 | 425 | 720 | .. | ... | EC | .... | .... | .... | ... |
| City of Fort Collins | Fort Collins, Colo. | G H Palmer | 8-40 | 425 | 739 | 1 | 25 | CE | 4.2 | .... | 1.4 | ... |
| City of Fairmont | Fairmont, Minn. | P B Muller | 7-40 | 425 | 650 | 2 | 35 | CE | 8.5 | .... | .... | ... |
| City of Piqua | Piqua, Ohio | Burns & McDonnell | 6-40 | 415 | 750 | 1 | 60 | BW | 7.0 | 0.3 | 2.5 | ... |
| City of Lamar | Lamar, Colo. | Burns & McDonnell | 1-40 | 415 | 750 | 1 | 30 | RS | 4.7 | 1.1 | 2.1 | DB |
| Valley City Elec & Wtr Wks. | Valley City, N. D. | ..... | 1-40 | 410 | 615 | 2 | 40 | EC | 5.0 | 0.2 | 2.6 | ... |
| City of Springfield | Springfield, Ill. | ..... | 11-40 | 410 | 700 | 2 | 160 | SB | 10.2 | 5.0 | 8.7 | DB |
| Borough of Ephrata | Ephrata, Pa. | Louis T Klauder | 12-39 | 400 | 750 | 1 | 45 | EM | 5.5 | 1.0 | 2.6 | DB |
| City of Kalamazoo | Kalamazoo, Mich. | Burns & McDonnell | 8-39 | 400 | 700 | 1 | 30 | SB | 3.5 | 0.3 | 1.1 | DB |
| City of Austin | Austin, Minn. | Helmick & Edeskuty | 4-40 | 400 | 700 | .. | ... | .... | .... | .... | .... | ... |
| City of McPherson | McPherson, Kan. | ..... | ..... | 400 | 675 | .. | ... | .... | .... | .... | .... | ... |
| City of Springfield | Springfield, Minn. | Charles Foster | 2-40 | 400 | 650 | 1 | 25 | RS | 3.8 | 0.8 | 1.1 | DB |
| Borough of Schuylkill Haven | Schuylkill Haven, Pa. | Louis T Klauder | 12-39 | 400 | 650 | 1 | 25 | BW | 4.1 | 0.2 | 1.1 | ... |
| City of Manitowoc | Manitowoc, Wis. | ..... | ..... | 400 | 625 | .. | ... | .... | .... | .... | .... | ... |
| City of Fulton | Fulton, Mo. | Baumes Engrg Co. | 3-40 | 400 | 560 | .. | ... | .... | .... | .... | .... | ... |
| City of Fort Wayne | Fort Wayne, Ind. | ..... | ..... | 400 | 750 | 1 | 125 | BW | .... | .... | .... | ... |
| **BELOW 400 LB** | | | | | | | | | | | | |
| City of Los Angeles | Los Angeles, Calif. | ..... | 3-40 | 375 | 750 | .. | ... | .... | .... | .... | .... | ... |
| City of Macon | Macon, Mo. | Baumes Engrg Co. | ..... | 300 | 700 | 1 | 25 | UI | 4.0 | .... | .... | ... |
| Board of Public Works | South Haven, Mich. | Hamilton & Weeber | 7-40 | 275 | 564 | .. | ... | .... | .... | .... | .... | ... |
| City of New London | New London, Iowa | Stanley Engrg Co. | 6-40 | 250 | 750 | 1 | 14 | BW | 1.9 | .... | 0.6 | ... |
| City of David City | David City, Neb. | Robert Fulton | 4-40 | 250 | 725 | 1 | 12 | MI | 2.5 | .... | .... | ... |
| Village of Hibbing | Hibbing, Minn. | ..... | ..... | 250 | 555 | .. | ... | .... | .... | .... | .... | ... |
| Town of Sibley | Sibley, Iowa | Stanley Engrg Co. | 3-40 | 250 | 550 | 1 | 30 | MI | .... | .... | .... | ... |
| City of Canton | Canton, Miss. | Rust Engineering Co. | ..... | 250 | 525 | 1 | 25 | RS | 3.2 | 0.7 | 1.2 | ... |
| Water & Light Dept. | Albion, Ind. | C C Wilcox | 7-39 | 250 | 520 | 2 | 10 | EK | 1.2 | 0.4 | 0.5 | ... |
| City of New Hampton | New Hampton, Iowa | Ralph D Thomas | 6-40 | 250 | 500 | 1 | 18 | MI | .... | .... | .... | ... |
| Village of Orrville | Orrville, Ohio | H Ralph Hadlow | 10-40 | 240 | 600 | .. | ... | .... | .... | .... | .... | ... |
| City of Muscatine | Muscatine, Iowa | Stanley Engrg Co. | 7-40 | 235 | 550 | .. | ... | .... | .... | .... | .... | ... |
| City of Crawfordsville | Crawfordsville, Ind. | H C Carroll | 1940 | 225 | 500 | .. | ... | .... | .... | .... | .... | ... |
| Town of Atlantic | Atlantic, Iowa | Stanley Engrg Co. | 1-40 | 225 | 500 | .. | ... | .... | .... | .... | .... | ... |
| City of Winfield | Winfield, Kan. | Black & Veatch | 11-39 | 200 | 450 | .. | ... | .... | .... | .... | .... | ... |
| Village of Litchfield | Litchfield, Minn. | Charles Foster | 8-39 | 200 | Sat | 1 | 45 | WB | 5.2 | .... | 1.8 | ... |
| City of East Palestine | E Palestine, Ohio | F S Barckhoff | 12-39 | 190 | Sat | .. | ... | .... | .... | .... | .... | ... |
| City of Coldwater | Coldwater, Mich. | Froelich & Emery | ..... | 180 | Sat | .. | ... | .... | .... | .... | .... | ... |
| Town of Wilson | Wilson, N. C. | ..... | ..... | ... | ... | .. | ... | .... | .... | .... | .... | ... |
| City of Mt. Pleasant | Mt. Pleasant, Iowa | Stanley Engrg Co. | 12-39 | ... | ... | .. | ... | .... | .... | .... | .... | ... |
| City of Blackwell | Blackwell, Okla. | Black & Veatch | 3-39 | ... | ... | .. | ... | .... | .... | .... | .... | ... |
| City of Schuyler | Schuyler, Neb. | Black & Veatch | 8-40 | ... | ... | .. | ... | .... | .... | .... | .... | ... |
| City of Moorhead | Moorhead, Minn. | Helmick & Edeskuty | ..... | ... | ... | .. | ... | .... | .... | .... | .... | ... |

# Continued From Preceding Two Pages

| Heat Liberation, 1000 Btu per Cu Ft | Economizer Surface per Boiler, 1000 Sq Ft | Air Heater Surface per Boiler, 1000 Sq Ft | FD FANS: Number per Boiler | FD FANS: Capacity Each, 1000 CFM | FD FANS: Drive | ID FANS: Number per Boiler | ID FANS: Capacity Each, 1000 CFM | ID FANS: Drive | Firing | FUEL: Heating Value, 1000 Btu per Lb | FUEL: Ash Fusion Temp, F | FEED PUMPS: Number | FEED PUMPS: Drive | TURBINES: Manufacturer | TURBINES: Speed, RPM | TURBINES: Capacity, 1000 Kw | TURBINES: Back pressure, Lb Abs | TURBINES: No. of Bleed Points | TURBINES: Bleed Press., Lb Abs | Condenser Surface 1000 Sq Ft |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.0 | 1.6 | .. | 1 | 25 | M | 1 | 50 | M | O | 19.4 | .... | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | G | .. | .... | 2 | SP | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .... | 1 | .. | M | .. | .. | .. | CG (180) | 12.6* | 2350 | 1 | T | ..... | .... | .... | .... | .. | .... | .... |
| 26.0 | .. | .. | .. | .. | .. | 1 | .. | M | G | 23.0 | .... | .. | SP | ..... | .... | .... | .... | .. | .... | .... |
| .. | 1.7 | .. | 1 | 14 | T | 1 | 21 | T | UF (97) | 14.0 | 2800 | 2 | T | BM | 1800 | 2.0 | 2.0 | .. | .... | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | UF (90) | 13.9 | 2600 | 2 | 1M, 1T | ..... | .... | .... | .... | .. | .... | .... |
| 22.0 | 1.2 | .. | 1 | 16 | M | 1 | 32 | M | UF (105) | 12.0 | 2300 | 2 | 1M, 1T | ..... | .... | .... | .... | .. | .... | .... |
| 21.0 | .. | .. | 1 | .. | T | 1 | .. | T | PC, G | 13.2 | 2600 | 1 | T | ..... | .... | .... | .... | .. | .... | .... |
| 34.7 | .. | .. | .. | .. | .. | .. | .. | .. | G | .... | .... | 2 | SP | ..... | .... | .... | .... | .. | .... | .... |
| 33.0 | .. | .. | 1 | 10 | M | .. | .. | .. | SS (57) | 11.9 | 2275 | 2 | SP | ..... | .... | .... | .... | .. | .... | .... |
| 28.8 | .. | .. | 1 | .. | M | .. | .. | .. | UF (69) | 12.4 | 2075 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | 1 | .. | M | .. | .. | .. | O | 18.3 | .... | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 34.0 | .. | .. | 1 | 18 | T | .. | .. | .. | CF (135) | 13.2 | 2360 | 2 | 1M, 1T | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | 1 | 12 | M | .. | .. | .. | (163) | .... | .... | 2 | ST | ..... | .... | .... | .... | .. | .... | .... |
| 39.0 | .. | .. | 1 | 16 | M | 1 | 30 | T | UF (78) | 14.0 | 2400 | 2 | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 30.0 | .. | .. | 1 | 17 | M | .. | .. | .. | CG (130) | 12.5 | 2150 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 25.1 | .. | 4.5 | 1 | 16 | M | 1 | 34 | M | PC | 14.0 | .... | 2 | 1M, 1T | GE | 3600 | 1.0 | 30.0 | .. | .... | .... |
| .. | .. | .. | 1 | 18 | M | .. | .. | .. | PC, G | 12.0 | 2600 | .. | ..... | WE | 3600 | 0.6 | 30.0 | .. | .... | .... |
| 68.0 | 3.1 | .. | 1 | 50 | D | 1 | 50 | D | TG (198) | 12.8 | 2200 | 3 | 1M, 2T | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | 1 | 23 | M | 1 | 30 | T | UF (114) | 14.0 | .... | 2 | 1M, 1T | WE | 3600 | 1.0 | 45 | .. | .... | .... |
| 25.0 | .. | 12.7 | 1 | .. | T | 1 | .. | T | PC | 14.2 | 2700 | 2 | T | WE | 3600 | 0.7 | .... | 1 | 45 | .... |
| 24.1 | 2.3 | 5.1 | 1 | 45 | M | 1 | 81 | M | SS (261) | 12.5 | 2150 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| 29.1 | 4.6 | .. | 2 | 98 | .. | 1 | 117 | D | UF (396) | 13.9 | 2800 | 6 | ..... | ..... | .... | .... | .... | .. | .... | .... |

# Under Construction Since January, 1939

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24.4 | .. | 12.7 | 1 | 18 | M | 1 | 26 | M | O | 18.5 | .... | 2 | 1M, 1T | GE | 3600 | 7.5 | 0.7 | 2 | 185–20 | 5.8 |
| 34.2 | .. | 10.1 | 1 | 32 | M | 1 | 62 | M | G, O | 18.5 | .... | 3 | M | AC | 3600 | 12.0 | 1.0 | 4 | 235–10 | 8.0 |
| 23.4 | .. | 6.5 | 1 | 10 | M | 1 | 21 | M | PC | 11.5 | 1900 | 3 | 1T, 2M | MS | 3600 | 3.0 | 1.0 | 3 | 230–60 | 3.0 |
| 26.1 | .. | 56.1 | 2 | 86 | M | 2 | 148 | M | PC | 12.2 | 2000 | 4 | 3M, 1T | AC | 3600 | 25.0 | 0.5 | 4 | 161–7 | 25.0 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | AC | 3600 | 12.5 | 250.0 | .. | ..... | .... |
| 35.0 | .. | 19.6 | 1 | 55 | M | 1 | 92 | M | G, O | 18.5 | .... | 2 | M | GE | 3600 | 20.0 | 1.0 | 4 | 442–21 | 16.0 |
| 36.8 | 2.9 | .. | 1 | 36 | M | 1 | 81 | D | UF (208) | 13.7 | 2800 | 3 | 2M, 1T | AC | 3600 | 7.5 | 0.7 | 4 | 290–8 | 8.5 |
| 31.0 | .. | 6.7 | 1 | 28 | M | 1 | 51 | M | O | 18.5 | .... | 2 | 1M, 1T | AC | 3600 | 7.5 | 0.7 | 4 | 290–8 | 8.5 |
| .. | .. | 4.5 | 1 | 32 | M | 1 | 75 | M | UF (196) | 14.2 | 2550 | 1 | M | AC | 3600 | 5.0 | 2.0 | 2 | ..... | 10.0 |
| 29.2 | .. | .. | 1 | .. | M | 1 | .. | M | UF | 12.4 | 2720 | 3 | 2M, 1T | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | MS | 3600 | 1.5 | 1.0 | 2 | 93–24 | 2.0 |
| 25.2 | .. | 5.6 | 1 | 23 | M | 1 | 47 | D | PC | 14.0 | 2300 | 2 | T | GE | 3600 | 3.0 | 1.0 | 2 | .... | 3.0 |
| 31.3 | 3.2 | .. | 1 | .. | T | 1 | .. | M | UF (161) | 12.0 | 2100 | 2 | 1M, 1T | GE | 3600 | 5.0 | 1.0 | 2 | 30–21 | 7.0 |
| 27.2 | 1.8 | 8.3 | 1 | .. | M | 1 | .. | M | PC | 14.0 | 2250 | 2 | 1M, 1T | WE | 3600 | 2.5 | 1.0 | 1 | 10 | 4.0 |
| .. | .. | .. | 1 | 10 | M | .. | .. | .. | CG (84) | 12.5 | 2300 | 3 | M | WE | 3600 | 6.0 | 1.2 | 2 | 90–30 | 6.1 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | ES | 3600 | 2.0 | 0.7 | 2 | 100–13 | 2.1 |
| 24.1 | .. | 7.2 | 1 | 26 | M | 1 | 60 | M | PC, O | 13.0 | 2400 | 2 | 1M, 1T | GE | 3600 | 7.5 | 0.5 | 2 | 109–33 | 10.0 |
| 25.0 | 1.8 | .. | .. | .. | .. | 1 | 32 | M | G, O | 1.0 | .... | 2 | 1M, 1T | AC | 3600 | 5.0 | 0.75 | 2 | 140–10 | 5.0 |
| 21.5 | .. | .. | 1 | 35 | M | 1 | 70 | M | PC, O | 12.4 | 2480 | 3 | 2M, 1T | GE | 3600 | 4.0 | 0.95 | 3 | 180–13 | 5.5 |
| 25.5 | .. | .. | .. | .. | .. | 1 | 35 | M | G, O | 1.0 | .... | 1 | M | WE | 3600 | 7.5 | 0.95 | 3 | 132–7 | 10.0 |
| 27.0 | 1.7 | .. | 1 | 5 | M | 1 | 30 | M | SS (120) | 9.7 | .... | 2 | 1M, 1T | WE | 3600 | 7.5 | 0.95 | 3 | 132–7 | 10.0 |
| 26.1 | .. | .. | .. | .. | .. | 1 | 25 | M | G | 1.0 | .... | 2 | 1M, 1T | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | GE | 3600 | 2.0 | 1.0 | 2 | 37–17 | 2.5 |
| 28.1 | .. | .. | 1 | .. | M | 1 | .. | M | SS | 9.5 | 2150 | .. | ..... | GE | 3600 | 1.5 | 0.96 | 2 | 120–12 | 3.0 |
| .. | .. | .. | 1 | .. | D | .. | .. | .. | WC (171) | 11.9 | .... | 2 | 1M, 1T | DL | 3600 | 4.0 | 0.7 | 3 | 124–15 | 4.5 |
| 29.4 | .. | 2.2 | 1 | .. | M | 1 | .. | M | UF (164) | 13.7 | 2400 | 1 | M | ..... | .... | .... | .... | .. | .... | .... |
| 25.0 | .. | 4.5 | 1 | .. | M | 1 | .. | M | G, O | 1.0 | .... | 1 | M | WE | 3600 | 2.5 | .... | 1 | 15 | 30 |
| 19.6 | .. | 2.6 | 1 | .. | T | 1 | .. | M | SS (141) | 6.6 | 1900 | 2 | T | WE | 3600 | 1.5 | .... | 1 | 15 | 2.0 |
| 23.0 | .. | 12.4 | 1 | 62 | M | 1 | 106 | M | PC | 10.0 | 1900 | 1 | M | EL | 3600 | 4.0 | 1.0 | 3 | 139–5 | 6.0 |
| 12.2 | .. | 4.1 | 1 | 17 | M | 1 | 30 | M | PC, O | 13.2 | 2300 | .. | ..... | EL | 3600 | 2.0 | 1.5 | 2 | 35–20 | 2.5 |
| .. | .. | 2.0 | 1 | 14 | M | 1 | 29 | M | UF (96) | 13.8 | 2600 | 2 | M | WE | 3600 | 2.5 | .... | .. | ..... | 4.2 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | ..... | 3600 | 1.5 | .... | .. | .... | 2.7 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | MS | 3600 | 1.0 | .... | .. | .... | 1.7 |
| 34.4 | .. | .. | 1 | .. | D | .. | .. | .. | UF (83) | 12.4 | 2200 | 2 | SP | MS | 3600 | 1.0 | 1.0 | 2 | 25–15 | 1.5 |
| 23.0 | .. | .. | 1 | 15 | M | .. | .. | .. | CG (107) | 12.0 | 2850 | .. | ..... | AC | 3600 | 2.0 | 0.75 | 3 | 15 | 5.0 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | AC | 3600 | 10.0 | 1.5 | 4 | 200–7 | 12.8 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | 2 | MT | WE | 3600 | 1.5 | 0.7 | 1 | 40 | 2.5 |
| .. | .. | .. | 1 | 39 | M | 1 | 65 | M | UF | 13.0 | 2750 | .. | ..... | GE | 3600 | 15.0 | 1.0 | 3 | .... | 14.0 |
| .. | .. | .. | .. | .. | .. | 2 | 300 | M | ..... | .... | .... | .. | ..... | ES | 3600 | 2.5 | 20.0 | .. | .... | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | CG (96) | 11.0 | .... | .. | ..... | WE | 3600 | 1.5 | 1.0 | 1 | .... | 3.0 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | GE | 3600 | 3.0 | 1.5 | 3 | .... | 4.3 |
| 40.0 | .. | .. | 1 | 5 | M | .. | .. | .. | SS (40) | .... | 1900 | 2 | SP | MI | 3600 | 0.4 | 1.0 | 2 | 18 | 0.45 |
| 40.0 | .. | 0.2 | 1 | .. | M | .. | .. | .. | SS (41) | 11.3 | 2150 | .. | ..... | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | WE | 3600 | 5.0 | 1.0 | 1 | 39 | 7.5 |
| 40.0 | .. | .. | 1 | 10 | M | .. | .. | .. | SS (80) | .... | 1900 | 2 | SP | MI | 3600 | 0.75 | 1.0 | 1 | 20 | 0.75 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | G, O | 1.0 | .... | 1 | SP | GE | 3600 | 0.75 | 2.0 | .. | .... | Jet |
| .. | .. | .. | 1 | 5 | M | .. | .. | .. | SS (42) | 14.0 | 2200 | 2 | SP | MI | .... | 0.5 | 1.0 | 1 | 14 | 0.9 |
| .. | .. | .. | 1 | .. | T | 1 | .. | T | UF | .... | .... | 2 | M | MS | .... | 0.3 | 1.0 | 1 | 14 | 0.8 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | ES | 3600 | 0.75 | .... | 1 | 20 | 1.4 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | AC | 3600 | 2.5 | 1.0 | 3 | 52–11 | 3.8 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | WE | 3600 | 7.5 | 1.0 | 3 | 131–12 | 7.3 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | WE | 3600 | 5.0 | 1.0 | .. | .... | 9.0 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | 1 | M | AC | 3600 | 1.5 | 1.0 | 1 | 18 | 2.4 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | AC | 3600 | 3.0 | 1.0 | 3 | 93–11 | 5.5 |
| 33.8 | .. | .. | 1 | 23 | M | .. | .. | .. | SS (121) | 13.1 | 2200 | 2 | SP, M | ..... | .... | .... | .... | .. | .... | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | WE | 3600 | 1.5 | 1.0 | 1 | 5 | 2.4 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | AC | 3600 | 2.5 | 1.0 | .. | .... | .... |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | 1 | M | GE | 3600 | 7.5 | 1.0 | 2 | 25 | 10.2 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | MS | 3600 | 1.5 | 1.0 | 1 | 18 | 2.8 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | .. | ..... | WE | 3600 | 5.0 | 1.0 | 2 | .... | 7.5 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | 2 | 1T, 1M | GE | 3600 | 1.0 | 0.7 | 2 | 78–10 | 1.6 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | ..... | .... | .... | | | GE | 3600 | 3.0 | 1.0 | 2 | .... | 3.8 |

# Typical Industrials 200 Lb and Under

Compiled by L N Bowley
*Associate Editor*

| Company | Location | First Operation, New Units | Pressure, Lb | BOILERS | | | | Firing | TURBINES OR ENGINES | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Steam Temp, F | Number | Capacity Each 1000 Lb per Hr | Manufacturer | | Manufacturer | Speed, RPM | Capacity, 1000 Kw | Backpressure, Lb Abs | No. of Bleed Points | Condenser Surface 1000 Sq Ft |
| **200 LB** | | | | | | | | | | | | | | |
| American Can Co | Montreal, Que | ..... | 200 | Sat | 2 | 30 | FW | O | .... | .... | .... | .... | .. | .... |
| Bergman's Laundry Inc | Washington, D. C | 10-39 | 200 | Sat | 1 | 12 | UI | O | WE | 5965 | 0.35 | 18 | .. | .... |
| Bowater's Nfld Pulp & Paper Mills | Corner Brook, Nfld | 12-40 | 200 | Sat | 2 | 80 | FW | PC, BA | .... | .... | .... | .... | .. | .... |
| E J Brach & Sons | Chicago, Ill | 7-39 | 200 | Sat | 1 | 43 | CE | CG | .... | .... | .... | .... | .. | .... |
| Canadian Auto Trim Co | Windsor, Ont | ..... | 200 | Sat | 1 | 15 | FW | O | .... | .... | .... | .... | .. | .... |
| Canadian Pacific RR | Montreal, Que | 1-41 | 200 | 495 | 2 | 100 | CE | PC | .... | .... | .... | .... | .. | .... |
| Carnation Co | Richland Center, Wis | 7-40 | 200 | 488 | 1 | 28 | UI | UF (77) | .... | .... | .... | .... | .. | .... |
| Converse Rubber Co | Malden, Mass | 8-40 | 200 | Sat | 1 | 13 | RS | O | .... | .... | .... | .... | .. | .... |
| Downing Box Co | Milwaukee, Wis | 6-40 | 200 | Sat | 2 | 10 | CB | O | .... | .... | .... | .... | .. | .... |
| Filtrol Corp | Los Angeles, Calif | 5-40 | 200 | .... | 1 | 10 | BW | G | .... | .... | .... | .... | .. | .... |
| General Foods Corp | St. Clair, Mich | ..... | 200 | 388 | .. | .... | .... | ..... | GE | 4897 | 0.75 | 1.5 | 1 | 0.8 |
| Goodall Worsted | Sanford, Me | 8-39 | 200 | 480 | 1 | 40 | FW | O | .... | .... | .... | .... | .. | .... |
| International Silver Co | Meriden, Conn | 10-40 | 200 | Sat | 2 | 25 | BI | O | .... | .... | .... | .... | .. | .... |
| Intercolonial Coal Co | Westville, N. S | ..... | 200 | Sat | 1 | 25 | FW | UF | .... | .... | .... | .... | .. | .... |
| Kirsch Co | Sturgis, Mich | 8-40 | 200 | Sat | 1 | 17 | UI | SS (123) | .... | .... | .... | .... | .. | .... |
| Lever Bros Co | Baltimore, Md | 12-39 | 200 | Sat | 1 | 100 | CE | UF (255) | .... | .... | .... | .... | .. | .... |
| Libby, McNeill & Libby | Chicago, Ill | ..... | 200 | Sat | 1 | 30 | UI | SS (95) | .... | .... | .... | .... | .. | .... |
| Morse Twist Drill & Mach Co | New Bedford, Mass | ..... | 200 | Sat | 1 | 26 | BW | O | .... | .... | .... | .... | .. | .... |
| Ohio Wax Paper Co | Columbus, Ohio | 4-40 | 200 | 475 | 1 | 30 | RS | UF (95) | .... | .... | .... | .... | .. | .... |
| Ontario Paper Co | Thorold, Ont | 1-39 | 200 | Sat | 1 | 18 | FW | HS (52) | .... | .... | .... | .... | .. | .... |
| Pairpoint Corp | New Bedford, Mass | ..... | 200 | Sat | 1 | 30 | BI | SS (90) | .... | .... | .... | .... | .. | .... |
| Pratt & Whitney Div | W. Hartford, Conn | 11-39 | 200 | Sat | 3 | 35 | UI | O | .... | .... | .... | .... | .. | .... |
| Rockport Water Wks Co | Rockport, Ind | 4-40 | 200 | 518 | .. | .... | .... | ..... | GE | 3600 | 0.75 | 2 | .. | 1.7 |
| Schuster Woolen Co | E. Douglas, Mass | 7-39 | 200 | 490 | 3 | 18 | BI | O | GE | 3600 | 1.25 | 2 | 1 | 2.5 |
| J. M Smucker Co | Orrville, Ohio | .... | 200 | Sat | 1 | 20 | BW | UF | .... | .... | .... | .... | .. | .... |
| Standard Furniture Co | Herkimer, N. Y | 12-39 | 200 | 388 | 1 | 25 | UI | WW | .... | .... | .... | .... | .. | .... |
| Twin Milk Producers Assn | Anoka, Minn | 3-40 | 200 | Sat | 1 | 30 | WB | SS (62) | SK | 257 | 0.1 | 20 | .. | .... |
| Western Condensing Co | Appleton, Wis | 6-40 | 200 | Sat | 1 | .... | UI | PC | .... | .... | .... | .... | .. | .... |
| George Ziegler Co | Milwaukee, Wis | 12-39 | 200 | 485 | 1 | 23 | EM | PC | .... | .... | .... | .... | .. | .... |
| **160 LB TO 199 LB** | | | | | | | | | | | | | | |
| British American Oil Co | Moosejaw, Sask | 7-40 | 190 | 470 | 1 | 18 | FW | O, G | .... | .... | .... | .... | .. | .... |
| British American Oil Co | Montreal, Que | 11-39 | 190 | 500 | 1 | 45 | FW | O, G | .... | .... | .... | .... | .. | .... |
| Godchaux Sugars Inc | Raceland, La | 10-39 | 180 | Sat | 1 | .... | HV | HS (251) | .... | .... | .... | .... | .. | .... |
| Republic Oil Refining Co | Texas City, Texas | ..... | 180 | Sat | 1 | 35 | HV | O&G | .... | .... | .... | .... | .. | .... |
| Riteway Laundry | Brooklyn, N. Y | ..... | 180 | 370 | 1 | 13 | BW | O | .... | .... | .... | .... | .. | .... |
| Shamrock Oil & Gas Co | Sunray, Texas | 1-40 | 180 | 420 | 1 | 36 | HV | G | .... | .... | .... | .... | .. | .... |
| Waterbury Button Co | Waterbury, Conn | 10-39 | 180 | 450 | 1 | 15 | RS | UF (59) | TE | 3600 | 0.3 | .... | 1 | 0.5 |
| Kieckhefer Container Co | Manitowoc, Wis | 10-39 | 178 | Sat | 1 | .... | CB | O | .... | .... | .... | .... | .. | .... |
| Archer-Daniels-Midland Co | Decatur, Ill | 12-39 | 175 | Sat | 3 | 30 | WB | SS (108) | .... | .... | .... | .... | .. | .... |
| Socony-Vacuum Oil Co | E. St. Louis, Ill | 10-39 | 175 | 390 | 3 | 50 | HV | O. G | .... | .... | .... | .... | .. | .... |
| The M Werk Co | St Bernard, Ohio | ..... | 175 | Sat | 1 | 31 | BW | PC | .... | .... | .... | .... | .. | .... |
| Wrought Iron Range Co | St. Louis, Mo | 1-40 | 175 | Sat | 1 | .... | CE | G | .... | .... | .... | .... | .. | .... |
| Consolidated Paper Co | Monroe, Mich | ..... | 165 | Sat | 1 | 100 | BW | UF | .... | .... | .... | .... | .. | .... |
| Acme Paperboard Co | Whitehall, Md | 11-39 | 160 | 400 | 1 | 35 | UI | O | .... | .... | .... | .... | .. | .... |
| Amalgamated Sugar Co | Lewiston, Utah | 10-40 | 160 | Sat | 2 | 75 | EC | SS (213) | .... | .... | .... | .... | .. | .... |
| American Ecla Corp | Fairfield, Conn | 2-39 | 160 | 353 | 1 | 9 | BW | O | .... | .... | .... | .... | .. | .... |
| Anniston Mfg Co | Anniston, Ala | ..... | 160 | Sat | 1 | .... | BW | UF | .... | .... | .... | .... | .. | .... |
| Bethlehem Steel Co, Inc | Lackawanna, N. Y | ..... | 160 | 566 | 1 | 30 | EM | CG (146) | .... | .... | .... | .... | .. | .... |
| Boston Elevated RR Co | Everett, Mass | 1-40 | 160 | Sat | 1 | 32 | BI | O | .... | .... | .... | .... | .. | .... |
| Chesebrough Mfg Co | Perth Amboy, N. J | 5-40 | 160 | Sat | 1 | 37 | BW | O | .... | .... | .... | .... | .. | .... |
| Church Grape Juice Co | Kennewick, Wash | 8-40 | 160 | .... | 1 | .... | BW | UF (30) | .... | .... | .... | .... | .. | .... |
| A Davis & Son Ltd | Kingston, Ont | 10-39 | 160 | 430 | 1 | 15 | FW | SS (48) | .... | .... | .... | .... | .. | .... |
| Electric Reduction Co | Buckingham, Que | 2-40 | 160 | Sat | 1 | 22 | FW | WC (72) | .... | .... | .... | .... | .. | .... |
| E I duPont de Nemours | New Brunswick, N. J | 11-39 | 160 | Sat | 1 | 13 | EM | PC | .... | .... | .... | .... | .. | .... |
| Great Western Sugar Co | Gering, Neb | 10-39 | 160 | Sat | 7 | .... | BW | CG | GE | 3600 | 1.5 | 20.0 | .. | .... |
| Jackson Brewing Co | New Orleans, La | 1-41 | 160 | Sat | 1 | 14 | MI | G | .... | .... | .... | .... | .. | .... |
| Marshall Field & Co | Draper, N. C | 12-39 | 160 | Sat | 2 | 16 | CE | ..... | .... | .... | .... | .... | .. | .... |
| McCreary Tire & Rubber Co | Indiana, Pa | 6-39 | 160 | Sat | 1 | 25 | EK | UF (75) | VI | 100 | 0.3 | 15.0 | .. | .... |
| Lebanon Woolen Mills | Lebanon, Tenn | 8-40 | 160 | Sat | 1 | 20 | BW | UF (56) | .... | .... | .... | .... | .. | .... |
| National Carbon Co | Fostoria, Ohio | 10-39 | 160 | Sat | 1 | 35 | BW | CG (104) | .... | .... | .... | .... | .. | .... |
| Pfeffer Rice Milling Co | Houston, Tex | 9-39 | 160 | Sat | 1 | .... | CE | RH | .... | .... | .... | .... | .. | .... |
| F W Poe Mfg Co | Greenville, S. C | ..... | 160 | Sat | 1 | .... | EK | UF | .... | .... | .... | .... | .. | .... |
| St Regis Paper Co | Trenton, N. J | 9-40 | 160 | 370 | 1 | 40 | EC | PC | .... | .... | .... | .... | .. | .... |
| Thermatomic Carbon Co | Sterlington, La | 6-40 | 160 | .... | 1 | 98 | BW | WG | .... | .... | .... | .... | .. | .... |
| U. S. Rubber Co | Mishowaka, Ind | ..... | 160 | 366 | 1 | 50 | BW | CG (158) | .... | .... | .... | .... | .. | .... |
| Ward Baking Co | Chicago, Ill | ..... | 160 | 370 | 2 | 16 | BW | UF (56) | .... | .... | .... | .... | .. | .... |
| **150 LB AND BELOW** | | | | | | | | | | | | | | |
| Abbott Laboratories | N. Chicago, Ill | 2-40 | 150 | Sat | 1 | 40 | BW | SS (120) | .... | .... | .... | .... | .. | .... |
| American Rolling Mill Co | Butler, Pa | ..... | 150 | 460 | 1 | 40 | BW | UF (108) | .... | .... | .... | .... | .. | .... |
| American Smelting & Ref Co | Garfield, Utah | ..... | 150 | 365 | .. | .... | .... | ..... | GE | 3600 | 2.5 | 1.0 | 1 | 3.5 |
| Atlantic Steel Co | Atlanta, Ga | ..... | 150 | Sat | 1 | 20 | CE | G | .... | .... | .... | .... | .. | .... |
| British American Oil Co | Toronto, Ont | 12-39 | 150 | 440 | 2 | 15 | FW | O, G | .... | .... | .... | .... | .. | .... |
| Brown & Williamson Tob Corp | Louisville, Ky | 9-40 | 150 | 360 | 2 | 39 | HV | PC | .... | .... | .... | .... | .. | .... |
| Curtiss-Wright Corp | Buffalo, N. Y | 3-40 | 150 | Sat | 1 | 70 | RS | PC | .... | .... | .... | .... | .. | .... |
| Delia Waste Products Co | Brooklyn, N. Y | 1-40 | 150 | Sat | 1 | 11 | CB | O | .... | .... | .... | .... | .. | .... |
| C H Dexter & Son | Windsor Locks, Conn | ..... | 150 | Sat | 1 | 15 | BI | O | .... | .... | .... | .... | .. | .... |
| Empire Brick & Supply Co | Newton Hook, N. Y | 4-39 | 150 | Sat | 1 | 25 | RS | UF (100) | .... | .... | .... | .... | .. | .... |
| W P McDonald Const Co | Flushing, N. Y | 2-40 | 150 | Sat | 1 | 9 | CB | O | .... | .... | .... | .... | .. | .... |
| Wm McIntosh Inc | Richmond, Va | 2-40 | 150 | Sat | 1 | 5 | CB | O | .... | .... | .... | .... | .. | .... |
| Monarch Rubber Co | Hartville, Ohio | ..... | 150 | Sat | 1 | 23 | UI | SS | .... | .... | .... | .... | .. | .... |
| Park Drop Forge Co | Cleveland, Ohio | ..... | 150 | Sat | 1 | 37 | BW | UF (145) | .... | .... | .... | .... | .. | .... |
| St. Joseph Lead Co. of Pa | Monaca, Pa | 10-40 | 150 | Sat | 1 | 10 | BW | UF (54) | .... | .... | .... | .... | .. | .... |
| Shannon Hosiery Mills | Columbus, Ga | 4-39 | 150 | Sat | 1 | .... | RC | G | .... | .... | .... | .... | .. | .... |
| Siemon Co | Bridgeport, Conn | 10-39 | 150 | Sat | 1 | 18 | BI | O | .... | .... | .... | .... | .. | .... |
| Smith Paper Inc | Lee, Mass | 1-40 | 150 | Sat | 2 | 20 | RS | UF (67) | GE | 5700 | 0.13 | 25.0 | .. | .... |
| Standard Oil Co (Pa.) | Pittsburgh, Pa | 10-40 | 150 | 466 | 1 | 35 | CE | UF (103) | .... | .... | .... | .... | .. | .... |
| Std Overall & Dry Clean Co | Irvington, N. J | 6-39 | 150 | Sat | 1 | 7 | CB | O | .... | .... | .... | .... | .. | .... |
| M T Stevens & Sons | N. Andover, Mass | ..... | 150 | Sat | 5 | 15 | BI | O | .... | .... | .... | .... | .. | .... |
| Kurth Malting Co | Milwaukee, Wis | 1-40 | 135 | 358 | 1 | 22 | WB | SS (90) | AC<br>VI | 150<br>100 | 0.2<br>0.3 | 20.0<br>20.0 | .. | .... |
| Republic Creosoting Co | St. Louis Park Mo | 12-39 | 130 | 355 | 1 | 20 | RS | PP | .... | .... | .... | .... | .. | .... |
| Wyman-Gordon Co | Worcester, Mass | 10-40 | 130 | 355 | 2 | 30 | BW | O | .... | .... | .... | .... | .. | .... |
| Flambeau Paper Co | Park Fales, Wis | ..... | 125 | .... | 1 | 30 | BW | SS (157) | .... | .... | .... | .... | .. | .... |
| Lydia Cotton Mills, Inc | Clinton, S. C | 3-39 | 125 | Sat | 1 | 10 | RS | UF | .... | .... | .... | .... | .. | .... |
| Phila Toilet & Lndry Co | Philadelphia, Pa | 12-39 | 125 | Sat | 2 | 12 | CB | O | .... | .... | .... | .... | .. | .... |
| Wickwire Spencer Steel Co | Clinton, Mass | 10-40 | 125 | Sat | 1 | 15 | RS | UF (46) | .... | .... | .... | .... | .. | .... |
| J Supple's Sons Planting Co | Bayou Goula, La | 10-39 | 110 | Sat | 1 | 50 | HV | O, B | .... | .... | .... | .... | .. | .... |
| Electric Auto-Lite Co | Springfield, Ohio | 7-40 | 100 | Sat | 1 | .... | BW | UF | .... | .... | .... | .... | .. | .... |

# Typical Institutionals Installed or on Order Since January, 1939

Compiled by L N Rowley
*Associate Editor*

| Company | Location | First Operation, New Units | Pressure, Lb | BOILERS: Steam Temp, F | BOILERS: Number | BOILERS: Capacity Each 1000 Lb per Hr | BOILERS: Manufacture | BOILERS: Firing | TURBINES OR ENGINES: Manufacture | TURBINES OR ENGINES: Speed, RPM | TURBINES OR ENGINES: Capacity, 1000 Kw | TURBINES OR ENGINES: Back-pressure, Lb Abs | TURBINES OR ENGINES: No. of Bleed Points | Condenser Surface 1000 Sq Ft |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ABOVE 200 LB** | | | | | | | | | | | | | | |
| Parkchester Housing Project | Bronx, N. Y. | 11–39 | 450† | 600 | 4 | 135 | FW | O | .... | .... | .... | .... | .. | .... |
| U. S. Navy Yard | Brooklyn, N. Y. | 10–40 | 405† | 700 | 1 | 150 | RS | UF (379) | EL | 3600 | 6.0 | 1.0 | 1 | 9.2 |
| University of Illinois | Champaign, Ill. | 9–40 | 325 | 650 | 3 | 80 | SB | CG (297) | GE | 3600 | 3.0 | .... | 1 | 2.5 |
| | | | | | | | | | GE | 3600 | 3.0 | 85.0 | .. | .... |
| University of Minnesota | St. Paul, Minn. | 10–40 | 310 | 700 | 2 | 35 | RS | PC | .... | .... | .... | .... | .. | .... |
| Iowa State College | Ames, Iowa | 1–41 | 250 | 506 | 1 | 80 | RS | TG (338) | .... | .... | .... | .... | .. | .... |
| U. S. Navy Armor Plate Plant | S. Charleston, W. Va. | 1941 | 250 | .... | 2 | 90 | RS | G | .... | .... | .... | .... | .. | .... |
| Kansas State College | Manhattan, Kan. | 6–40 | 250 | 500 | 1 | 45 | MI | G | WE | 3600 | 1.0 | 5.0 | .. | .... |
| University of Michigan | Ann Arbor, Mich. | 12–39 | 200 | Sat | 1 | 120 | WI | UF (297) | GE | 3600 | 4.0 | 28.0 | 2 | .... |
| Veterans Administration Facility | Knoxville, Iowa | 10–39 | 200 | .... | 4 | 16 | MI | SS (80) | .... | .... | .... | .... | .. | .... |
| Magee Hospital | Pittsburgh, Pa. | ..... | 200 | Sat | 1 | 25 | RS | UF (73) | .... | .... | .... | .... | .. | .... |
| Fairfield State Hospital | Newtown, Conn. | 11–39 | 200 | Sat | 1 | 25 | BI | OF (100) | TE | 4200 | 0.5 | 5.0 | .. | .... |
| Federal Penitentiary | Terre Haute, Ind. | 9–40 | 200 | .... | 4 | .... | UI | OF (66) | .... | .... | .... | .... | .. | .... |
| Iowa State Hospital | Mt. Pleasant, Iowa | ..... | 200 | .... | 1 | 23 | MI | CG (130) | .... | .... | .... | .... | .. | .... |
| University of Idaho | Moscow, Idaho | 10–40 | 200 | Sat | 1 | 30 | CE | PC | .... | .... | .... | .... | .. | .... |
| Kings Park State Hospital | Kings Park, L. I., N. Y. | 10–40 | 200 | .... | .. | .... | .... | ..... | WE | 3600 | 1.2 | 15.0 | .. | .... |
| McChord Field, U. S. Army | McChord Field, Wash. | 6–40 | 200 | 388 | 2 | .... | EC | SS | .... | .... | .... | .... | .. | .... |
| Presbyterian Bldg. | New York, N. Y. | 1940 | 200 | Sat | 2 | 11 | EK | O | SK | 327 | 0.4 | 18.0 | .. | .... |
| Scott Field, U. S. Army | Belleville, Ill. | ..... | 200 | 388 | 2 | .... | EC | ..... | .... | .... | .... | .... | .. | .... |
| U. S. Navy Yard | Charleston, S. C. | ..... | 200 | 465 | 2 | 25 | UI | UF | MS | 3600 | 2.5 | .... | .. | .... |
| Valley City Normal School | Valley City, N. D. | ..... | 200† | 331 | 1 | 9 | UI | SS (84) | .... | .... | .... | .... | .. | .... |
| University of S. Dakota | Vermillion, S. D. | 9–40 | 150 | Sat | 1 | 40 | MI | G | .... | .... | .... | .... | .. | .... |
| University of Wisconsin | Madison, Wis. | ..... | 200 | .... | 2 | .... | SB | UF (100) | .... | .... | .... | .... | .. | .... |
| **160 TO 199 LB** | | | | | | | | | | | | | | |
| Minot Normal School | Minot, N. D. | 9–39 | 180 | 200 | 1 | .... | UI | SS (110) | MI | 3900 | 0.1 | 4.0 | .. | .... |
| State Teachers College | Cedar Falls, Iowa | 1940 | 162 | .... | .. | .... | .... | ..... | MI | 3600 | 1.0 | 7.0 | .. | .... |
| Childrens Hospital | Philadelphia, Pa. | 7–40 | 160 | 425 | 1 | 15 | BD | O | .... | .... | .... | .... | .. | .... |
| Delaware Hospital | Wilmington, Del. | 7–40 | 160† | Sat | 3 | 17 | EM | O | .... | .... | .... | .... | .. | .... |
| Allegheny County Institution | Woodville, Pa. | 4–40 | 160 | Sat | 2 | .... | BW | CG (90) | .... | .... | .... | .... | .. | .... |
| Methodist Hospital | Memphis, Tenn. | 5–40 | 160 | .... | 1 | 10 | BW | G | .... | .... | .... | .... | .. | .... |
| Mission of the Immaculate Virgin | Mt. Loretto, S. I., N. Y. | ..... | 160 | Sat | 3 | 14 | CE | O | .... | .... | .... | .... | .. | .... |
| Pratt Institute | Brooklyn, N. Y. | ..... | 160 | Sat | 2 | 10 | CE | TG (58) | .... | .... | .... | .... | .. | .... |
| University of Alabama | University, Ala. | 12–39 | 160 | Sat | 2 | .... | HV | UF (87) | .... | .... | .... | .... | .. | .... |
| Wright Field, U. S. Army | Dayton, Ohio | ..... | 160 | .... | 2 | 15 | MI | ..... | .... | .... | .... | .... | .. | .... |
| U. S. Government | Ft. Leavenworth, Kan. | 9–39 | 160 | .... | 1 | 9 | MI | G | .... | .... | .... | .... | .. | .... |
| U. S. Dept. of Agriculture | Albany, Calif. | 12–40 | 160 | .... | 3 | 14 | UI | O&G | .... | .... | .... | .... | .. | .... |
| **BELOW 160 LB** | | | | | | | | | | | | | | |
| U. S. Naval Air Station | Alameda, Calif. | 9–40 | 160 | Sat | 3 | 24 | EM | O&G | .... | .... | .... | .... | .. | .... |
| Chanute Field, U. S. Army | Rantoul, Ill. | 3–40 | 150 | 366 | 2 | 50 | EC | SS (128) | .... | .... | .... | .... | .. | .... |
| | | | | | 3 | 100 | EC | SS (252) | .... | .... | .... | .... | .. | .... |
| Clinton Prison | Dannemora, N. Y. | ..... | 150 | 366 | 2 | 17 | .... | UF (80) | GE | 3600 | 1.3 | 10.0 | .. | .... |
| Criminal Courts Bldg. | New York, N. Y. | ..... | 150 | 365 | 4 | 48 | HV | O | .... | .... | .... | .... | .. | .... |
| N. Y. State Dept. of Correction | Stormville, N. Y. | 9–40 | 150 | 315 | 4 | 20 | UI | UF (125) | FS | 150 | 0.5 | 10.0 | .. | .... |
| N. C. State Hospital | Goldsboro, N. C. | ..... | 150 | Sat | 1 | 36 | RS | PC | .... | .... | .... | .... | .. | .... |
| U. S. Delaware Ordnance Dept. | Pedricktown, N. J. | 11–39 | 150 | Sat | 1 | 5 | CB | O | .... | .... | .... | .... | .. | .... |
| Veterans Administration Facility | Bedford, Mass. | 1–40 | 100 | 340 | 1 | .... | CE | SS (60) | .... | .... | .... | .... | .. | .... |
| Yorktowne Hotel | York, Pa. | ..... | 150 | .... | 1 | 9 | CE | UF (36) | .... | .... | .... | .... | .. | .... |
| Dept. of the Interior | Chilocco, Okla. | 11–40 | 140 | .... | 1 | 16 | MI | G | .... | .... | .... | .... | .. | .... |
| | | | | | 1 | 7 | MI | G | .... | .... | .... | .... | .. | .... |
| 415 Fifth Ave. Corp. | New York, N. Y. | 7–40 | 140 | .... | .. | .... | .... | ..... | TE | .... | 0.3 | .... | .. | 1.3 |
| University of Delaware | Newark, Del. | ..... | 125 | Sat | 1 | 11 | EM | UF (65) | .... | .... | .... | .... | .. | .... |
| Independent School District | Des Moines, Iowa | 1–40 | 125 | 350 | 1 | .... | WB | SS (75) | .... | .... | .... | .... | .. | .... |
| St. Paul Union Depot | St. Paul, Minn. | 9–39 | 125 | .... | 1 | 25 | WB | OF | .... | .... | .... | .... | .. | .... |
| U. S. Horticultural Station | Beltsville, Md. | 11–39 | 125 | Sat | 3 | 23 | RS | SS | .... | .... | .... | .... | .. | .... |
| U. S. Naval Operating Base | Norfolk, Va. | 9–40 | 125 | .... | 1 | 75 | RS | O | .... | .... | .... | .... | .. | .... |
| Veterans Administration Facility | Downey, Ill. | 1–40 | 125 | .... | 1 | .... | CE | ..... | .... | .... | .... | .... | .. | .... |
| Yale University | New Haven, Conn. | 8–40 | 125 | Sat | .. | .... | .... | ..... | WE | 3800 | 0.7 | 20.0 | .. | .... |
| University of Houston | Houston, Tex. | 7–39 | 110 | .... | 1 | .... | BW | G | .... | .... | .... | .... | .. | .... |
| N. C. State Capitol Heating Plant | Raleigh, N. C. | 10–39 | 100 | Sat | 3 | 18 | RS | UF (56) | .... | .... | .... | .... | .. | .... |
| State Hospital | Jamestown, N. D. | 12–39 | 250† | 440 | 2 | 20 | BW | SS (115) | MI | 4500 | 0.2 | 5.0 | .. | .... |
| | | | | | | | | | MI | 4500 | 0.2 | 5.0 | .. | .... |

## TABLE OF SYMBOLS AND ABBREVIATIONS

*A* —Air cooling
*AC* —Allis-Chalmers Mfg Co
*AS* —Acid sludge
*B* — Bagasse
*BA* —Bark
*BD* —Badenhausen
*BFG* —Blast-furnace gas
*BI* —The Bigelow Co
*BL* —Black liquor
*BM* —Bellis & Morcom
*BW* —Babcock & Wilcox Co
*C* —Coal, bituminous
*CA* —Coal, anthracite
*CB* —Cleaver-Brooks Co
*CE* —Combustion Engineering Co
*CF* —Compensating-feed stoker
*CG* —Chain-grate stoker
*COG* —Coke-oven gas
*CY* —Cyclone
*D* —Dual drive
*DB* —Dry bottom
*EC* —Erie City Iron Works
*EK* —E Keeler Co.
*EL* —Elliott Co.
*EM* —Edge Moor Iron Works
*EP* —Electrostatic precipitator
*F* —Cinder-eliminator fan
*FS* —Filer & Stowell Co
*FW* —Foster Wheeler Corp
*Fu* —Future installation
*G* —Gas
*GE* —General Electric
*H* —Hydrogen cooling
*HS* —Hofft stoker
*M* —Motor drive
*MI* —Murray Iron Works
*MS* —Moore Steam Turbine Corp
*O* —Oil
*OF* —Overfeed stoker
*P* —Precipitator
*PC* —Pulverized coal
*PCk* —Pulverized coke
*PP* —Pulverized pitch
*RC* —R D Cole Mfg Co
*RG* —Refinery Gas
*RH* —Rice hulls
*RS* —Riley Stoker Corp
*S* —Sludge
*SB* —Springfield Boiler Co
*SK* —Skinner Engine Co
*SP* —Steam pump
*SS* —Spreader stoker
*ST* —Slag tap
*T* —Turbine drive
*TE* —Terry Steam Turbine Co
*TG* —Traveling-grate stoker
*UF* —Underfeed stoker
*UI* —Union Iron Works
*VI* —Vilter Mfg Co
*WB* —Wm Bros Boiler & Mfg Co
*WC* —Water-cooled stoker
*WE* —Westinghouse Elec & Mfg Co
*WG* —Waste gas
*WI* —Wickes Boiler Co
*WW* —Wood waste
*X* —Waterwall heating surface included in boiler surface
* —Dry basis
** —Mixed-pressure turbine
† —Design, now operating at lower pressure
(150) —Stoker grate area, sq. ft.

Under turbines, number preceding name of manufacturer denotes number of units. Absence of number denotes single unit.

Under turbine bleed pressures, if there are more than 2 bleed points, two pressures given are high and low

# Hydroelectric Projects Built or on Order in

Compiled by F A Annett
Associate Editor

| Company | Designing Engineer | Project Name | New or Redevelop | River | State | Project Started | Dam Type | Crest Length, Feet | Max. Height, Feet | Unit Operation | Total Horsepower |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **NEW ENGLAND STATES** | | | | | | | | | | | |
| Central Maine Power Co | New England Power Serv Co | Williams | New | Kennebec | Me. | 1937 | CG | 375 | 30 | 1939 | 10,150 |
| Central Maine Power Co | | Wyman | New | Kennebec | Me. | 1928 | EF | .... | ... | 1930 | 68,000 |
| Public Electric Light Co | Charles T Main, Inc | Milton | New | Lamoille | Vt. | 1938 | .... | .... | ... | 1938 | 4,500 |
| Great Northern Paper Co | | Mattaceunk | New | ..... | Me. | 1937 | .... | .... | ... | 1939 | 11,800 |
| Bangor Hydro-Electric Co | Bangor Hydro-Elec Co | Ellsworth | Redev | Union | Me. | 1937 | Am | 275 | 60 | 1938 | 5,800 |
| Bangor Hydro-Electric Co | Bangor Hydro-Elec Co | Veazie | Redev | Penobscot | Me. | 1938 | Am | 571 | 25 | 1939 | 6,860 |
| Strathmore Paper Co | | | Redev | ..... | Mass. | 1938 | .... | .... | ... | 1939 | ..... |
| Fellows Gear Shaper Co | | | | | Vt | 1939 | .... | .... | ... | 1940 | ..... |
| City of Holyoke | | | | | Mass. | 1939 | .... | .... | ... | 1940 | ..... |
| Kerzar Falls Woolen Co | | | | | Me. | 1939 | .... | .... | ... | 1940 | ..... |
| Citizens Utilities Co | Charles T Main, Inc | Newport | New | Clyde | Vt. | 1937 | M | 250 | 20 | 1938 | 2,400 |
| **MIDDLE ATLANTIC STATES** | | | | | | | | | | | |
| Safe Harbor Water Power Corp | Penn Water & Power Co | Safe Harbor | New | Susquehanna | Pa. | 1930 | CGG | 5,000 | 65 | 1931 | 261,200 |
| Rockland Light & Power Co | Charles T Main, Inc | Swing Bridge | New | ..... | N.Y. | 1928 | Earth | 1,000 | 135 | 1929 | 7,000 |
| | | | Add | Mongaup | N.Y. | 1938 | | | | | |
| Central N Y. Power Corp | | Norwood | ..... | Racquette | N.Y. | 1939 | .... | .... | ... | 1940 | ..... |
| **EAST NORTH CENTRAL STATES** | | | | | | | | | | | |
| Michigan Public Service Co | | Boyne City | ..... | ..... | Mich. | .... | .... | .... | ... | 1939 | ..... |
| Kimberly-Clark Corp | | Niagara | ..... | ..... | Wis. | 1939 | .... | .... | ... | 1940 | ..... |
| Neshonoc Light & Power Co | | West Salem | ..... | ..... | Wis. | 1938 | .... | .... | ... | 1939 | ..... |
| Consolidated Wt Pr & Water Co | | Wis. Rapids | ..... | ..... | Wis. | 1939 | .... | .... | ... | 1940 | ..... |
| City of Kaukauna | | Kaukauna | ..... | ..... | Mich. | 1938 | .... | .... | ... | 1939 | 3,300 |
| Middleville Power Corp | | Middleville | ..... | ..... | Mich. | 1938 | .... | .... | ... | 1939 | ..... |
| | | Irving | ..... | ..... | Mich. | 1938 | .... | .... | ... | 1939 | ..... |
| Firestone Plantation Co (Liberia, Africa) | Company Engrs | Lower Falls | New | Farmington | ..... | 1940 | CG | 875 | 15 | 1941 | 1,325 |
| Ford Motor Co | | Manchester | ..... | ..... | Mich. | 1939 | .... | .... | ... | 1940 | ..... |
| Indianapolis Water Co | | Indianapolis | ..... | ..... | Ind. | 1939 | .... | .... | ... | 1940 | ..... |
| Illinois Iowa Power Co | | Marseilles | ..... | ..... | Ill. | 1938 | .... | .... | ... | 1939 | ..... |
| **WEST NORTH CENTRAL STATES** | | | | | | | | | | | |
| Central Neb Pub Pr & Irrig Dist | Owners Eng Staff | Johnson No. 2 | New | Platte | Neb. | 1939 | EF | 10,400 | 160 | 1941 | 25,000 |
| Central Neb Pub Pr & Irrig Dist | Owners Eng Staff | Johnson No. 1 | New | Platte | Neb. | 1939 | EF | 10,400 | 160 | 1941 | 26,000 |
| Central Neb Pub Pr & Irrig Dist | Owners Eng Staff | Jeffery Canyon | New | Platte | Neb. | 1938 | EF | 10,400 | 160 | 1941 | 26,000 |
| City of Fort Dodge, Iowa | | | New | ..... | Iowa | 1939 | .... | .... | ... | 1940 | 600 |
| Bowersock Mills & Pr Co | J D Bowersock | Lawrence | Redev | Kansas | Kan. | 1939 | RFC | 14 | 17 | 1940 | 1,640 |
| General Mills, Inc | | Minneapolis | ..... | ..... | Minn. | 1939 | .... | .... | ... | 1940 | ..... |
| U. S. Engineer Corps | U. S. Engineer Corps | Wappapello | New | ..... | Mo. | 1939 | .... | .... | ... | 1940 | ..... |
| City of Cedar Falls | | Cedar Falls | New | ..... | Iowa | 1939 | .... | .... | ... | 1940 | 1,940 |
| **SOUTH ATLANTIC STATES** | | | | | | | | | | | |
| Appalachian Electric Power Co | | | New | New | Va. | 1937 | .... | .... | ... | 1939 | ..... |
| City of Danville | Charles T Main, Inc | Pinnacles | New | Dan | Va. | 1936 | Arch | 575 | 130 | 1938 | 13,500 |
| | | | | | | | Arch | 520 | 140 | | |
| Greenwood County Bd of Comm | | Buzzards | New | Saluda | S.C. | .... | Earth | 2,000 | 85 | 1940 | 22,200 |
| Sellers Mfg Co | | Saxapahaw | ..... | ..... | N.C. | 1938 | .... | .... | ... | 1939 | ..... |
| Glen Raven Silk Mills | | Glen Raven | ..... | ..... | N.C. | 1939 | .... | .... | ... | 1940 | ..... |
| Ware Shoals Mfg Co | | Ware Shoals | New | ..... | S.C. | 1939 | .... | .... | ... | 1940 | ..... |
| S. Carolina Public Serv Auth | Harza Engineering Co | Santee-Cooper | New | Santee | S.C. | 1938 | HR | 3,100 | 40 | 1941 | 173,300 |
| Virginia Electric Power Co | Stone & Webster | C & O Canal | New | James | Va. | 1939 | .... | .... | ... | 1940 | 3,880 |
| City of Abbeville, S. C | Wiedeman & Singleton | Rocky River | New | Rocky | S.C. | 1939 | MA | 85 | 85 | 1940 | 4,250 |
| J M Odell Mfg Co | | Pittsboro | ..... | ..... | N.C. | 1939 | .... | .... | ... | 1940 | ..... |
| Virginia Woolen Mills | | | ..... | ..... | N.C. | 1939 | .... | .... | ... | 1939 | ..... |
| Crisp County Power Comm | | | New | Flint | Ga. | 1939 | .... | .... | ... | 1940 | ..... |
| Fields Mfg Co | | | ..... | ..... | Ga. | 1938 | .... | .... | ... | 1939 | ..... |
| City of Augusta, Ga | Robert Co | River station | New | Savannah | Ga. | 1938 | M | 1,600 | 8 | 1939 | 1,560 |
| **EAST SOUTH CENTRAL STATES** | | | | | | | | | | | |
| U. S. Tenn. Valley Authority | Tenn. Valley Auth | Kentucky | New | Tennessee | Tenn. | 1938 | CG | 8,650 | 160 | 1945 | ..... |
| U. S. Tenn. Valley Authority | Tenn. Valley Auth | Chickamauga | New | Tennessee | Tenn. | 1936 | CGG | 5,794 | 108 | 1940 | 108,000 |
| U. S. Tenn. Valley Authority | Tenn. Valley Auth | Guntersville | New | Tennessee | Ala. | 1935 | CGG | 3,985 | 94 | 1939 | 102,000 |
| U. S. Tenn. Valley Authority | Tenn. Valley Auth | Hiwassee | New | Hiwassee | N.C. | 1937 | CG | 1,265 | 307.5 | 1940 | 80,000 |
| U. S. Tenn. Valley Authority | Tenn. Valley Auth | Watts Bar | New | Tennessee | Tenn. | 1939 | CGG | 2,970 | 97 | 1942 | 126,000 |
| U. S. Tenn. Valley Authority | U. S. Bureau of Reclam | Wheeler | New | Tennessee | Ala. | 1933 | CGG | 6,335 | 68 | 1936 | 90,000 |
| U. S. Tenn. Valley Authority | Tenn Valley Auth | Pickwick | New | Tennessee | Tenn. | 1935 | EF | 7,715 | 110 | 1939 | 110,000 |
| U. S. Tenn. Valley Authority | U. S. Engineer Corps | Wilson | New | Tennessee | Ala. | 1918 | CGG | 4,500 | 95 | 1926 | 260,000 |
| U. S. Tenn. Valley Authority | Tenn. Valley Auth | Fort Loudoun | New | Tennessee | Tenn. | 1940 | CGG | 3,900 | 135 | 1944 | 120,000 |
| **WEST SOUTH CENTRAL STATES** | | | | | | | | | | | |
| Lower Colorado River Auth | Lower Colo. River Auth | Marshall Ford | New | Colorado | Texas | 1938 | CG | 700 | 225 | 1941 | 90,000 |
| Lower Colorado River Auth | Lower Colo. River Auth | Tom Miller | New | Colorado | Texas | 1938 | CG | 1,200 | 112.5 | 1940 | 20,000 |
| Grand River Dam Authority | Holway & Neuffer | Pensacola Dam | New | Grand | Okla. | 1938 | MA | 6,100 | 150 | 1941 | 80,000 |
| Brazos River Conserv & Rec Dist | Amberson Constr Co | Possum Kingdom | New | Brazos | Texas | 1938 | AM | 2,740 | 190 | 1940 | 34,000 |
| Arkansas Missouri Power Co | | Blytheville | Redev | ..... | Ark. | 1939 | .... | .... | ... | 1940 | ..... |

# the United States and Canada in 1939-40

| Added Cap. No. of Units | Date of Added Cap. | Ultimate Cap. Horsepower | No. of Units Installed | Water-Wheel Capacity, Horsepower | Water-Wheel Type | Speed, RPM | Static Head, Ft | Design Head, Ft | Water-Wheel Manufacturer | Governor Manufacturer | Draft Tube, Type | Scroll Case, Type | Penstock Valves, Type | Generator Capacity, Kva | Thrust-Bearing Location | Power Factor | Kilovolts | Cycles | Generator Manufacturer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ... | .... | 20,300 | 1 | 10,150 | Kaplan | 150 | 36–44 | 42 | MS | W | Elbow | Concrete | Head Ga | 8,000 | AG | 0.80 | 6.9 | 60 | GE |
| 1 | .... | 102,000 | 2 | 34,000 | Francis | 138.5 | 145–120 | 135 | AC | AC | Elbow | Plate St | Head Ga | 26,667 | AG | 0.90 | 13.8 | 60 | GE |
| 1 | 1940 | ..... | 1 | 34,000 | Francis | 138.5 | 145–120 | 135 | AC | AC | Elbow | Plate St | Head Ga | 26,667 | AG | 0.90 | 13.8 | 60 | GE |
| ... | .... | 9,000 | 1 | 4,500 | Francis | 277 | 100 | 95 | MS | L | Elbow | Plate St | Head Ga | 3,750 | AG | 0.80 | 2.4 | 60 | GE |
| 1 | 1940 | 18,050 | 2 | 5,900 | Kaplan | 171.4 | 39 | 39 | BS | W | Elbow | Concrete | Head Ga | 6,000 | AG | 0.80 | 6.9 | 60 | GE |
| | | | 1 | 6,250 | Prop. | 171.4 | 39 | 39 | BS | W | Elbow | Concrete | Head Ga | 6,000 | AG | 0.80 | 6.9 | 60 | GE |
| 2 | 1938 | 11,600 | 2 | 2,900 | Kaplan | 360 | 60 | 60 | MS | W | Elbow | Plate St | Head Ga | 2,500 | AG | 0.80 | 2.3 | 60 | GE |
| 2 | 1939 | 10,000 | 2 | 2,070 | Prop. | 128.5 | 17 | 17 | MS | W | Elbow | Concrete | Head Ga | 1,875 | AG | 0.80 | 6.0 | 60 | GE |
| ... | .... | ..... | 2 | ..... | ..... | 400 | .... | .... | ..... | .. | ..... | ..... | ..... | 500 | HS | 0.80 | 0.6 | 60 | GE |
| ... | .... | ..... | 1 | ..... | ..... | 900 | .... | .... | ..... | .. | ..... | ..... | ..... | 156 | HS | 0.80 | 0.6 | 60 | GE |
| ... | .... | ..... | 1 | 746 | ..... | 128.5 | .... | 12.5 | ..... | W | ..... | ..... | ..... | 563 | AG | 0.80 | 4.8 | 60 | GE |
| ... | .... | ..... | 1 | ..... | ..... | 180 | .... | .... | ..... | .. | ..... | ..... | ..... | 438 | AG | 0.80 | 2.4 | 60 | GE |
| . | .... | 4,800 | 1 | 2,400 | Francis | 360 | 142 | 135 | AC | W | Elbow | Plate St | Butterfly | 1,875 | AG | 0.80 | 2.4 | 60 | GE |
| 1 | 1940 | 4,800 | 1 | 2,400 | Francis | 360 | 142 | 135 | AC | W | Elbow | Plate St | Butterfly | 1,875 | AG | 0.80 | 2.4 | 60 | GE |
| | | | 5 | 42,500 | Kaplan | 109.1 | 55.5 | 53.5 | 2MS | W | Elbow | Concrete | Head Ga | 36,000 | BG | 0.80 | 13.8 | 60 | 3GE |
| | | | | | | | | | 3BS | W | Elbow | Concrete | Head Ga | 36,000 | BG | 0.80 | 13.8 | 60 | 2WE |
| ... | .... | 510,000 | 1 | 42,500 | Kaplan | 100 | 55.5 | 53.5 | MS | W | Elbow | Concrete | Head Ga | 37,500 | BG | 0.80 | 13.3 | 25 | GE |
| | | | 2 | 3,100 | Francis | 180 | 55.5 | 53.5 | MS | W | Elbow | Concrete | Head Ga | 2,500 | BG | 0.70 | 0.48 | 60 | WE |
| 1 | 1940 | | 1 | 42,500 | Kaplan | 100 | 55.5 | 53.5 | BS | W | Elbow | Concrete | Head Ga | 35,000 | BG | 0.80 | 13.3 | 25 | GE |
| ... | .... | 17,800 | 1 | 7,000 | ..... | .... | ..... | .... | ..... | .. | ..... | ..... | ..... | 5,000 | AG | 0.90 | 4.0 | 60 | ..... |
| 1 | 1939 | ..... | 1 | 10,800 | Francis | 120 | 125–95 | 120 | MS | W | Elbow | Plate St | Head Ga | 7,500 | AG | 0.90 | 4.0 | 60 | WE |
| | | | 1 | 740 | Francis | 120 | 14 | 14 | JL | W | Elbow | Concrete | Head Ga | ..... | .... | .... | ..... | .. | GE |
| ... | .... | ..... | 1 | 335 | Francis | 180 | 14 | 14 | JL | W | Elbow | Concrete | Head Ga | ..... | .... | .... | ..... | .. | GE |
| ... | .... | ..... | 1 | 750 | ..... | 277 | 32 | 32 | .... | W | Elbow | Concrete | Head Ga | 625 | AG | 0.80 | 6.9 | 60 | GE |
| ... | .... | ..... | 1 | 2,600 | Francis | 240 | 65 | 63 | JL | .. | Horizontal Shaft | | Drives pulp grinder | ... | .... | .... | ..... | .. | ..... |
| ... | .... | ..... | 1 | 180 | Francis | 120 | 14 | 14 | JL | W | Elbow | Concrete | Head Ga | 156 | AG | 0.80 | 2.4 | 60 | EM |
| ... | .... | ..... | 1 | 900 | Francis | 240 | 30 | 30 | JL | W | Drives grinder and generator | | | ..... | .... | .... | ..... | .. | ..... |
| ... | .... | ..... | 1 | 3,300 | Kaplan | 138.5 | 22 | 22 | MS | W | Elbow | Concrete | Head Ga | 3,000 | AG | 0.80 | 2.4 | 60 | EM |
| ... | .... | ..... | 1 | 518 | ..... | 150 | 12 | 12 | .... | W | Elbow | Concrete | Head Ga | 438 | AG | 0.80 | 2.5 | 60 | EM |
| ... | .... | ..... | 1 | 810 | ..... | 200 | 18 | 18 | .... | W | Elbow | Concrete | Head Ga | 750 | AG | 0.80 | 2.5 | 60 | EM |
| ... | .... | 5,300 | 1 | 1,325 | Francis | 360 | 69–55 | 65 | AC | W | Elbow | Plate St | Head Ga | 938 | AG | 0.80 | 2.4 | 60 | AC |
| ... | .... | ..... | 1 | 160 | Francis | 400 | 20 | 20 | JL | .. | ..... | ..... | ..... | 125 | AG | 0.80 | 0.208 | 60 | EM |
| | | | 1 | 60 | Francis | 450 | 20 | 20 | JL | .. | ..... | ..... | ..... | 50 | AG | 0.80 | 0.208 | 60 | EM |
| ... | .... | ..... | 3 | 53 | Francis | 700 | 155 | 150 | JL | .. | Drives centrifugal pumps | | | | | | | | |
| ... | .... | ..... | 1 | 382 | Francis | 120 | 13.5 | 13.5 | JL | W | Elbow | Concrete | Head Ga | 325 | AG | 0.80 | 2.3 | 60 | GE |
| ... | .... | 50,000 | 1 | 25,000 | Francis | 164 | 146 | 141 | NN | W | Elbow | Plate St | Head Ga | 20,000 | AG | 0.90 | 6.9 | 60 | GE |
| ... | .... | 26,000 | 2 | 13,000 | Francis | 180 | 118 | 98 | MS | W | Elbow | Plate St | Head Ga | 10,000 | AG | 0.90 | 6.9 | 60 | AC |
| ... | .... | 26,000 | 2 | 13,000 | Francis | 180 | 116 | 110 | MS | W | Elbow | Plate St | Head Ga | 10,000 | AG | 0.90 | 6.9 | 60 | AC |
| ... | ..... | ..... | 1 | 600 | Francis | 100 | 16 | 16 | JL | .. | ..... | ..... | ..... | ..... | .... | .... | ..... | .. | EM |
| 1 | 1940 | 2,100 | 1 | 460 | Francis | 109 | 17 | 17 | JL | W | Conical | Open flume | ..... | 400 | AG | 0.90 | 2.3 | 60 | EM |
| ... | .... | ..... | 1 | 825 | Francis | 327 | 47 | 47 | JL | .. | Elbow | Concrete | Head Ga | 750 | AG | 0.80 | 0.48 | 60 | EM |
| ... | .... | ..... | 1 | 120 | Francis | 300 | 15 | 15 | JL | W | ..... | ..... | ..... | 100 | AG | 0.80 | 0.48 | 60 | GE |
| ... | .... | ..... | 2 | 970 | Francis | 100 | 12 | 12 | JF | W | Elbow | ..... | Head Ga | 750 | AG | 0.80 | 2.4 | 60 | EM |
| ... | .... | ..... | 4 | 26,000 | Francis | 138.5 | 115 | 110 | 2NN | W | Elbow | ..... | ..... | 20,833 | BG | 0.90 | 11.5 | 60 | WE |
| | | | | | | | | | 2AC | W | | | | | | | | | |
| ... | .... | 13,500 | 3 | 4,500 | Impulse | 450 | 680–701 | 660 | MS | W | ..... | ..... | Butterfly | 3,750 | HS | 0.90 | 4.16 | 60 | GE |
| ... | .... | 30,000 | 3 | 7,400 | Kaplan | 240 | 60 | 60 | BS | W | Elbow | Concrete | Head Ga | 6,250 | AG | 0.80 | 4.15 | 60 | GE |
| ... | .... | ..... | 1 | 1,520 | Francis | 120 | 28 | 28 | JL | W | Elbow | ..... | Head Ga | 1,250 | AG | 0.80 | 2.4 | 60 | GE |
| | | | 1 | 890 | Francis | 125 | 28 | 28 | JL | W | Elbow | ..... | Head Ga | 750 | AG | 0.80 | 2.4 | 60 | AC |
| ... | .... | ..... | 1 | 320 | Francis | 180 | 20 | 20 | JL | W | Elbow | ..... | Head Ga | 312 | AG | 0.80 | 0.6 | 60 | WE |
| ... | .... | ..... | 1 | 3,780 | Kaplan | 360 | 67 | 64 | MS | .. | Elbow | Concrete | Head Ga | 3,000 | AG | 0.80 | 2.4 | 60 | GE |
| ... | .... | 213,000 | 2 | 40,000 | Kaplan | 120 | 77–60 | 70 | AC | W | Elbow | Concrete | Head Ga | 34,000 | BG | 0.90 | 13.8 | 60 | WE |
| | | | 2 | 40,000 | Prop | 120 | 77–60 | 70 | NN | W | Elbow | Concrete | Head Ga | 34,000 | BG | 0.90 | 13.8 | 60 | GE |
| | | | 1 | 13,300 | Kaplan | 200 | 77–60 | 70 | AC | W | Elbow | Concrete | Head Ga | 11,350 | BG | 0.90 | 13.8 | 60 | GE |
| ... | .... | 3,880 | 1 | 3,880 | Kaplan | 257 | 49–41 | 46 | MS | W | Elbow | Concrete | Head Ga | 3,000 | AG | 0.70 | 13.2 | 60 | WE |
| ... | .... | 4,250 | 1 | 3,000 | Francis | 300 | 70–90 | 80 | MS | W | Elbow | Concrete | Gate Valve | 2,250 | AG | 0.80 | 2.4 | 60 | WE |
| | | | 1 | 1,250 | Francis | 400 | 70–90 | 80 | MS | W | Elbow | Steel | Gate Valve | 1,000 | AG | 0.80 | 2.4 | 60 | WE |
| ... | .... | ..... | 1 | 800 | Francis | 474 | 18 | 18 | JL | .. | ..... | ..... | Head Ga | 750 | AG | 0.80 | 0.6 | 60 | GE |
| ... | .... | ..... | 1 | ..... | ..... | 200 | .... | .... | ..... | .. | ..... | ..... | ..... | 312 | AG | 0.80 | 2.4 | 60 | WE |
| ... | .... | ..... | 1 | 6,800 | Prop | 128.5 | 30 | 30 | NN | W | Elbow | Concrete | Head Ga | 6,000 | AG | 0.80 | 2.3 | 60 | GE |
| ... | .... | ..... | 1 | 221 | ..... | 200 | 11 | 11 | ..... | W | ..... | ..... | ..... | 187 | AG | 0.80 | 2.3 | 60 | WE |
| ... | .... | ..... | 2 | 780 | Francis | 257 | 30 | 30 | JL | .. | ..... | ..... | Head Ga | Drives pumps | | | | | |
| ... | .... | ..... | .. | 44,000 | Kaplan | 78.3 | 58–20 | 48 | ..... | .. | Elbow | Concrete | Head Ga | ..... | BG | 0.90 | 13.8 | 60 | ..... |
| ... | .... | 144,000 | 3 | 36,000 | Kaplan | 75 | 36 | 36 | BS | W | Elbow | Concrete | Head Ga | 30,000 | BG | 0.90 | 13.8 | 60 | AC |
| ... | .... | 136,000 | 3 | 34,000 | Kaplan | 69.2 | 36 | 36 | MS | W | Elbow | Concrete | Head Ga | 27,000 | BG | 0.90 | 13.8 | 60 | GE |
| ... | .... | 160,000 | 1 | 80,000 | Francis | 120 | 195 | 190 | NN | W | Elbow | Plate St | Head Ga | 64,000 | BG | 0.90 | 13.8 | 60 | WE |
| ... | .... | 210,000 | 3 | 42,000 | Kaplan | 94.7 | 60–40 | 52 | BS | W | Elbow | Concrete | Head Ga | 33,333 | BG | 0.90 | 13.8 | 60 | WE |
| . | .... | 360,000 | 2 | 45,000 | Prop | 85.7 | 54–43 | 48 | BS | W | Elbow | Concrete | Head Ga | 36,000 | BG | 0.90 | 13.8 | 60 | GE |
| 2 | 1941 | ..... | 2 | 45,000 | Prop | 85.7 | 54–43 | 48 | BS | W | Elbow | Concrete | Head Ga | 36,000 | BG | 0.90 | 13.8 | 60 | GE |
| . | .... | 330,000 | 2 | 55,000 | Kaplan | 81.8 | 60–30 | 47 | AC | AC | Elbow | Concrete | Head Ga | 36,000 | BG | 0.90 | 13.8 | 60 | GE |
| 1 | 1942 | ..... | 1 | 55,000 | Kaplan | 81.8 | 60–30 | 47 | AC | AC | Elbow | Concrete | Head Ga | 40,000 | BG | 0.90 | 13.8 | 60 | WE |
| . | .... | 610,000 | 4 | 30,000 | Francis | 100 | 95 | 92 | BS | BS | Elbow | Concrete | Head Ga | 24,000 | AG | 0.90 | 13.8 | 60 | WE |
| . | .... | ..... | 4 | 35,000 | Francis | 100 | 95 | 92 | NN | W&L | Elbow | Concrete | Head Ga | 28,000 | AG | 0.90 | 13.8 | 60 | GE |
| 2 | 1941 | ..... | 2 | 35,000 | Francis | 100 | 95 | 92 | AC | .. | Elbow | Concrete | Head Ga | 28,000 | AG | 0.90 | 13.8 | 60 | AC |
| ... | .... | 240,000 | 2 | 60,000 | Kaplan | ... | 60–78 | ... | .... | .. | Elbow | Concrete | Head Ga | 48,000 | BG | 0.90 | 13.8 | 60 | ..... |
| ... | .... | 90,000 | 3 | 30,000 | Francis | 144 | 235–100 | 120 | BS | W | Elbow | Plate St | Head Ga | 25,000 | BG | 0.90 | 13.8 | 60 | GE |
| ... | .... | 20,000 | 2 | 10,000 | AAI' | 200 | 64–30 | 60 | NN | W | Elbow | Concrete | Head Ga | 7,500 | BG | 0.90 | 12.0 | 60 | WE |
| ... | .... | 100,000 | 4 | 20,000 | Francis | 150 | 135–85 | 115 | AC | W | Elbow | Plate St | Head Ga | 16,000 | BG | 0.90 | 13.8 | 60 | WE |
| | | | 1 | 750 | Francis | 720 | 135–85 | 115 | AC | W | ..... | ..... | ..... | 625 | HS | 0.80 | 0.48 | 60 | WE |
| ... | .... | 51,000 | 2 | 17,000 | Francis | 171.4 | 130–63 | 115 | AC | W | Elbow | Plate St | Head Ga | 12,500 | BG | 0.90 | 6.9 | 60 | GE |
| ... | .... | ..... | 2 | 410 | Francis | 200 | 20 | 20 | JL | .. | Elbow | Concrete | Head Ga | Old generators | | | ..... | .. | ..... |

# Hydroelectric Projects Built or On Order in

Compiled by F A Annett
*Associate Editor*
Company

| Designing Engineer | Project Name | *New or Redevelop | River | State, Province or Country | Project Started | *Dam Type | *Const Length, Feet | *Max. Height, Feet | *Initial Operation | *Initial Horsepower |
|---|---|---|---|---|---|---|---|---|---|---|
| **MOUNTAIN STATES** | | | | | | | | | | |
| U. S. Bur of Reclam | Boulder Dam | New | Colorado | Ariz. & Neb. | 1931 | GA | 1,180 | 730 | 1936 | 515,000 |
| U. S. Bur of Reclam | Elephant Butte | New | Rio Grande | N.M. | 1911 | CG | 1,162 | 306 | 1940 | 34,500 |
| U. S. Bur of Reclam | Green Mt | New | Blue | Colo. | 1938 | EF | 1,300 | 270 | 1942 | 30,000 |
| U. S. Bur of Reclam | Seminoe | New | N Platte | Wyo. | 1935 | CA | 540 | 261 | 1939 | 45,000 |
| U. S. Bur of Reclam | Minidoka | Redev | Snake | Idaho | 1904 | .... | .... | ... | 1910 | 9,000 |
| | | | | | .... | .... | .... | ... | .... | ..... |
| U. S. Engineer Corps<br>Harza Engrg Corp | Fort Peck | New | Missouri | Mont. | 1933 | EF | 21,000 | 250 | .... | 70,000 |
| M P Goudy & C R Black | Plant No. 4 | Redev | Snake | Idaho | 1937 | CG | 450 | 12 | 1940 | 2,350 |
| ..... | ..... | ..... | ..... | Colo. | 1939 | .... | .... | ... | 1940 | ..... |
| ..... | ..... | ..... | ..... | Utah | .... | .... | .... | ... | 1939 | ..... |
| City Engrg Dept | Manitou; | Redev | Ruxton | Colo. | .... | .... | .... | ... | 1928 | 7,000 |
| ..... | ..... | ..... | ..... | Utah | .... | .... | .... | ... | .... | ..... |
| ..... | ..... | New | Manti Cr. | Utah | 1940 | .... | .... | ... | 1941 | ..... |
| ..... | Cross Cut | Redev | ..... | Ariz. | 1938 | .... | .... | ... | 1939 | ..... |
| ..... | ..... | New | ..... | Wyo. | 1938 | .... | .... | ... | 1939 | ..... |
| ..... | ..... | New | ..... | Mont. | 1939 | .... | .... | ... | 1940 | ..... |
| **PACIFIC COAST STATES** | | | | | | | | | | |
| U. S. Bur of Reclam | Bonneville | New | Columbia | Wash. & Ore. | 1933 | CG | 900 | 170 | 1938 | 137,000 |
| U. S. Bur of Reclam | Grand Coulee | New | Columbia | Wash. | 1934 | CG | 4,500 | 553 | 1941 | 478,000 |
| U. S. Bur of Reclam | Shasta | New | Sacramento | Calif. | 1938 | CG | 3,500 | 560 | 1943 | 419,000 |
| U. S. Bur of Reclam | Parker Dam | New | Colorado | Calif. & Ariz. | 1934 | CA | 800 | 340 | 1941 | 120,000 |
| Pacific Gas & El Co | Phoenix | Redev | Stanislaus | Calif. | 1938 | CA | 520 | 125 | 1940 | 2,300 |
| Pacific Gas & Elec Co | Junction City | Redev | Canyon Cr. | Calif. | 1938 | RFC | 134 | 16 | .... | 3,300 |
| Pacific Gas & El Co | Potter Valley | Redev | Eel | Calif. | 1938 | CG | 752 | 130 | .... | 14,500 |
| U. S. Bur of Reclam | Drop No. 4 | New | AA Canal | Calif. | 1937 | None | .... | ... | 1940 | 13,300 |
| U. S. Bur of Reclam | Drop No. 3 | New | AA Canal | Calif. | 1937 | None | .... | ... | 1940 | 7,500 |
| U. S. Bur of Reclam | Wapato | New | ..... | Wash. | .... | .... | .... | ... | 1940 | 3,640 |
| ..... | Angeles | New | Stanislaus | Calif. | 1939 | .... | .... | ... | 1940 | 1,880 |
| ..... | ..... | ..... | ..... | Ore. | .... | .... | .... | ... | 1939 | ..... |
| ..... | Hamilton | Redev | ..... | Ore. | 1939 | .... | .... | ... | 1940 | ..... |
| **UNITED STATES POSSESSIONS** | | | | | | | | | | |
| ..... | Waiau | New | ..... | Hawaii | .... | .... | .... | ... | 1940 | ..... |
| ..... | ..... | New | ..... | Hawaii | .... | .... | .... | ... | 1939 | ..... |
| ..... | Hawi | New | ..... | Hawaii | .... | .... | .... | ... | 1940 | ..... |
| ..... | Caliraya | New | ..... | P.I. | 1938 | .... | .... | ... | 1941 | ..... |
| Owners Eng Staff | Garzas No. 1 | New | Garzas | Porto Rico | 1936 | REF | 835 | 195 | 1940 | 10,000 |
| Owners Eng Staff | Garzas No. 2 | New | Garzas | Rico | 1936 | REF | 835 | 195 | 1940 | 7,000 |
| ..... | ..... | ..... | ..... | ..... | .... | .... | .... | ... | .... | ..... |
| **CANADA** | | | | | | | | | | |
| ..... | Beauharnois | New | St. Lawrence | Que. | 1929 | P&G | 4,500 | 31 | 1932 | 440,000 |
| Shawinigan Eng Corp | La Tuque | New | St. Maurice | Que. | 1938 | CG | 1,325 | 131 | 1940 | 178,000 |
| ..... | Island Falls | New | ..... | Sask. | 1936 | .... | .... | ... | .... | 57,000 |
| Harza Engrg Co | Upper Falls | New | Montreal | Ont. | 1936 | EF | 775 | 32 | 1937 | 10,000 |
| Harza Engrg Co | Lower Falls | New | Montreal | Ont. | 1937 | .... | 1,400 | 32 | 1939 | 12,350 |
| Silas H Woodward | Rapids No. 7 | New | Ottawa | Que. | 1938 | Earth | 3,000 | 80 | 1941 | 48,000 |
| Company Eng Staff | No. 2 | New | Kootenay | B.C. | 1938 | CG | 1,060 | 20 | 1940 | 52,000 |
| Hydro-Elec Pr Comm | Ear Falls | New | English | Ont. | 1936 | CG | 60 | 46 | 1937 | 10,000 |
| Montreal Eng Co, Ltd | Hollow Bridge | New | Black | N.S. | 1939 | .... | .... | ... | 1940 | 7,500 |
| Bennett & White | Wellington Lake | New | Charlot | N.W.T. | 1938 | .... | .... | ... | 1939 | ..... |
| ..... | ..... | New | ..... | N.S. | 1938 | .... | .... | ... | 1939 | ..... |
| ..... | Conquerall Mills | New | Petite | N.S. | 1938 | .... | .... | ... | 1939 | 600 |
| ..... | ..... | New | Lachine Canal | Que. | .... | .... | .... | ... | .... | 800 |
| ..... | ..... | New | ..... | Ont. | 1938 | .... | .... | ... | 1939 | 216 |
| ..... | ..... | New | ..... | Ont. | 1938 | .... | .... | ... | 1939 | ..... |
| ..... | ..... | New | ..... | Que. | 1940 | .... | .... | ... | 1941 | ..... |
| ..... | ..... | New | ..... | Ont. | 1939 | .... | .... | ... | 1940 | 350 |
| Nova Scotia Pr Comm | Barrie Brook | New | Barrie | N.S. | 1939 | .... | .... | ... | 1940 | 500 |
| ..... | ..... | New | ..... | N.S. | 1939 | .... | .... | ... | 1941 | ..... |
| ..... | Plant No. 2 | New | La Sarre | Ont. | 1938 | .... | .... | ... | 1939 | 825 |
| ..... | ..... | New | Levier | Que. | 1939 | .... | .... | ... | 1940 | 2,500 |
| ..... | Winneway | New | ..... | Ont. | 1939 | .... | .... | ... | 1940 | 1,400 |
| ..... | ..... | ..... | ..... | Ont. | 1939 | .... | .... | ... | 1940 | ..... |
| ..... | ..... | ..... | ..... | B.C. | 1939 | .... | .... | ... | 1940 | 750 |
| ..... | Isle Maligne | New | Saguenay | Que. | 1939 | .... | .... | ... | 1940 | ..... |

AC —Allis-Chalmers Mfg Co
MS —S Morgan Smith Co
JL —James Leffel & Co
PW —Pelton Water Wheel Co
BS —Baldwin Southwark Corp
NN —Newport News Shipbuilding & Dry Dock Co
W —Woodward Governor Co
L —Lombard Governor Co
DEW —Dominion Engineering Works, Ltd
CAC —Canadian Allis Chalmers, Ltd
MSI —S Morgan Smith-Inglis, Ltd
GE —General Electric Co
WE —Westinghouse Elect & Mfg Co
EM —Electric Machinery Mfg Co
EC —Elliott Co
CWC —Canadian Westinghouse Co, Ltd
CGE —Canadian General Electric Co, Ltd
EEC —English Electric Co of Canada, Ltd
SGE —Swedish General Electric Co, Ltd
OC —Oerlikon, Canada, Ltd

# the United States and Canada in 1939-40

| Added Cap. No. of Units | Date of Added Cap. | Ultimate Cap. Horsepower | No. of Units Installed | Water-Wheel Capacity, Horsepower | Water-Wheel Type | Speed, RPM | Static Head, Ft | Design Head, Ft | Water-Wheel Manufacturer | Governor Manufacturer | Draft Tube, Type | Runoff Gate, Type | Penstock Valve, Type | Generator Capacity, Kva | Thrust-Bearing Location | Power Factor | Kilovolts | Cycles | Generator Manufacturer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ... | .... | 1,835,000 | S | 115,000 | Francis | 180 | 584–422 | .... 520 | 6AC 2PW | W W | Elbow | Cast St | Butterfly | 82,500 | AG | 1.00 | 16.5 | 60 | 4WE 4GE |
| | | | 1 | 55,000 | Francis | 237 | .... | 520 | NN | W | Elbow | Cast St | Butterfly | 40,000 | AG | 1.00 | 13.8 | 60 | AC |
| | | | 2 | 3,500 | Impulse | 300 | .... | 520 | PW | W | ..... | House Service | ..... | 3,000 | HS | 0.80 | 2.4 | 60 | EM |
| 2 | 1940 | ..... | 2 | 115,000 | Francis | 180 | .... | 520 | PW | W | Elbow | Cast St | Butterfly | 82,500 | AG | 1.00 | 16.5 | 60 | WE |
| ... | .... | 34,500 | 3 | 11,500 | Francis | 257 | 205–70 | 156 | NN | W | Elbow | Plate St | Head Ga | 9,000 | AG | 0.90 | 6.9 | 60 | AC |
| ... | .... | 30,000 | 2 | 15,000 | Francis | 257 | 262–107 | 203 | NN | W | Elbow | Plate St | Head Ga | 12,000 | AG | 0.90 | 6.9 | 60 | AC |
| ... | .... | 45,000 | 3 | 15,000 | Francis | 225 | 221–116 | 195 | PW | W | Elbow | Plate St | Head Ga | 12,000 | AG | 0.80 | 6.9 | 60 | AC |
| ... | .... | 26,500 | 6 | Five 1,800 installed in 1909 and one 3,500 installed in 1926 | | | | | | | | | | | | | | | |
| 1 | 1940 | ..... | 1 | 7,000 | Prop | 180 | 50–42 | 47 | BS | W | Elbow | Concrete | Head Ga | 6,000 | AG | 0.83 | 2.4 | 60 | WE |
| ... | .... | 150,000 | 1 | 50,000 | Francis | 128.5 | .... | 170 | MS | W | ..... | ..... | ..... | 38,889 | BG | 0.90 | 13.8 | 60 | AC |
| | | | 1 | 20,000 | Francis | 164 | .... | 140 | MS | W | ..... | ..... | ..... | 16,667 | BG | 0.90 | 13.8 | 60 | AC |
| ... | .... | 4,700 | 1 | 2,350 | Kaplan | 138 | 16–19 | 18 | MS | W | Elbow | Concrete | Head Ga | 1,875 | AG | 0.80 | 2.4 | 60 | GE |
| ... | .... | ..... | 1 | 300 | Francis | 400 | 20 | 28 | JL | W | Elbow | Concrete | Head Ga | 250 | AG | 0.80 | 2.5 | 60 | GE |
| ... | .... | ..... | 1 | ..... | ..... | 300 | .... | .... | .... | .. | ..... | ..... | ..... | 500 | HS | 0.80 | 2.3 | 60 | GE |
| | | | 1 | 900 | Impulse | 450 | .... | 455 | PW | W | ..... | Reconstructed | ..... | 750 | HS | 0.80 | 2.3 | 60 | GE |
| 1 | 1939 | 7,000 | 1 | 3,500 | Impulse | 900 | 2,421 | 2,300 | PW | PW | ..... | ..... | ..... | 2,500 | HS | 1.00 | 6.6 | 60 | WE |
| | | | 1 | 3,500 | Impulse | 900 | 2,421 | 2,300 | PW | PW | ..... | ..... | ..... | 2,500 | HS | 1.00 | 6.6 | 60 | WE |
| ... | .... | ..... | 1 | 750 | Impulse | 450 | .... | 560 | PW | .... | | Reconstructed | ..... | ..... | .... | .... | .... | .. | ..... |
| ... | .... | 520 | 1 | 520 | Impulse | 1,200 | 2,800 | 2,700 | PW | W | ..... | ..... | ..... | ..... | .... | .... | .... | .. | ..... |
| 1 | 1939 | 6,800 | 1 | 2,700 4,100 | Francis | 327 | 110 | 106 | JL | W | ..... | ..... | ..... | 2,650 3,750 | AG | 0.8 | 6.6 | 25 60 | EM |
| ... | .... | ..... | 1 | 400 | Francis | 450 | 36 | 36 | JL | W | ..... | ..... | ..... | 375 | AG | 0.8 | 2.3 | 60 | WE |
| ... | .... | ..... | 1 | 150 | Francis | 900 | 85 | 85 | JL | W | ..... | ..... | ..... | 125 | HS | 0.8 | 2.4 | 60 | GE |
| | | | 2 | 66,000 | Kaplan | 75 | 67–22 | 50 | MS | W | [5] EHS | Concrete | Head Ga | 54,000 | BG | 0.80 | 13.8 | 60 | GE |
| | | | 1 | 5,000 | Kaplan | 275 | 67–22 | 50 | MS | W | Elbow | Plate St | Head Ga | 3,200 | AG | 0.80 | 2.4 | 60 | EM |
| ... | .... | 665,000 | | | | | | | | | | | | | | | | | |
| 2 | 1940 | ..... | 2 | 74,000 | Kaplan | 75 | 67–22 | 60 | MS | W | [5] EHS | Concrete | Head Ga | 60,000 | BG | 0.80 | 13.8 | 60 | GE |
| 2 | 1941 | ..... | 2 | 74,000 | Kaplan | 75 | 67–22 | 60 | MS | W | [5] EHS | Concrete | Head Ga | 60,000 | BG | 0.80 | 13.8 | 60 | GE |
| ... | ....2,742,000 | | 3 | 150,000 | Francis | 120 | 358– | 330 | NN | W | Elbow | Cast St | Head Ga | 108,000 | AG | 1.00 | 13.8 | 60 | WE |
| | | | 2 | 14,000 | Francis | 400 | 266 | 335 | PW | W | ..... | ..... | Service Units | 12,500 | AG | 0.80 | 6.6 | 60 | WE |
| ... | .... | 521,000 | 4 | 103,000 | Francis | 150 | 480–243 | 330 | AC | AC | Elbow | Plate St | Head Ga | 75,000 | AG | 1.00 | 13.8 | 60 | GE |
| | | | 2 | 3,500 | Francis | 600 | 480–243 | 330 | JL | W | Conical | Cast St | Tube | 2,500 | AG | 0.80 | 2.4 | 60 | GE |
| ... | .... | 160,000 | 3 | 40,000 | Francis | 94.7 | 87–60 | 80 | MS | W | Elbow | Plate St | Head Ga | 30,000 | AG | 1.00 | 6.9 | 60 | WE |
| ... | .... | 2,300 | 1 | 2,300 | Impulse | 514 | 1,187 | 1,013 | PW | W | ..... | Reconstructed | ..... | 2,000 | HS | 0.80 | 2.4 | 60 | WE |
| ... | .... | 3,300 | 1 | 2,200 | Impulse | 400 | 600 | 600 | PW | PW | ..... | Reconstructed | ..... | 2,000 | HS | 1.00 | 2.3 | 60 | WE |
| | | | 1 | 1,100 | Impulse | 514 | 600 | 600 | PW | PW | ..... | Reconstructed | ..... | 720 | HS | 1.00 | 2.3 | 60 | GE |
| ... | .... | 14,500 | 1 | 6,500 | Francis | 720 | 476 | 425 | PW | W | Elbow | ..... | Butterfly | 5,500 | HS | 0.80 | 2.4 | 60 | WE |
| | | | 2 | 4,000 | Francis | 450 | 450 | 425 | AC | AC | Elbow | ..... | ..... | 2,500 | HS | 0.80 | 2.4 | 60 | AC |
| ... | .... | 26,600 | 1 | 13,300 | Prop | 150 | 56–49 | 51 | NN | W | Elbow | Concrete | Head Ga | 12,000 | AG | 0.80 | 6.9 | 60 | EC |
| ... | .... | 15,000 | 1 | 7,500 | Prop | 100 | 26 | 26 | BS | W | Elbow | Concrete | Head Ga | 6,000 | AG | 0.80 | 6.9 | 60 | GE |
| ... | .... | ..... | 1 | 3,640 | Francis | 164 | 31 | 31 | JL | W | Elbow | Concrete | Head Ga | 2,500 | AG | 0.80 | 2.4 | 60 | WE |
| ... | .... | ..... | 1 | 1,880 | Impulse | 450 | 406 | 404 | PW | W | ..... | ..... | ..... | 1,750 | HS | 0.80 | 2.4 | 60 | GE |
| ... | .... | ..... | 1 | 325 | ..... | 450 | .... | 248 | .... | W | ..... | ..... | ..... | 312 | HS | 0.80 | 2.4 | 60 | GE |
| ... | .... | ..... | 1 | 230 | Francis | 351 | 30 | 30 | JL | .. | ..... | ..... | ..... | 200 | HS | 0.80 | 2.3 | 60 | WE |
| ... | .... | ..... | 1 | 2,250 | Impulse | 320 | 420 | 400 | PW | W | ..... | ..... | ..... | 1,875 | HS | 0.80 | 2.3 | 60 | GE |
| ... | .... | ..... | 1 | ..... | ..... | 257 | .... | .... | .... | .. | ..... | ..... | ..... | 1,250 | HS | 0.80 | 6.6 | 60 | GE |
| ... | .... | ..... | 1 | 663 | Impulse | 514 | 515 | 500 | PW | .. | ..... | ..... | ..... | 625 | HS | 0.80 | 2.3 | 60 | GE |
| ... | .... | ..... | 3 | 12,500 | Francis | 720 | 900 | 891 | PW | .. | Elbow | Cast St | ..... | ..... | .... | .... | .... | .. | GE |
| ... | .... | ..... | 2 | 5,000 | Impulse | 450 | 1,262 | 1,200 | MS | W | ..... | ..... | Butterfly | 4,500 | HS | 0.80 | 2.3 | 60 | GE |
| ... | .... | ..... | 1 | 7,000 | Impulse | 360 | 812 | 800 | PW | W | ..... | ..... | Butterfly | 6,300 | HS | 0.80 | 2.3 | 60 | WE |
| ... | .... | ..... | 1 | 600 | Francis | 720 | 110 | 104 | JL | W | ..... | ..... | ..... | ..... | .... | .... | .... | .. | GE |
| | | | 4 | 53,000 | Francis | 75 | 83 | 80 | DEW | DEW | Elbow | Concrete | Head Ga | 43,886 | BG | 0.85 | 13.2 | 25 | 1 OC 3 CGE |
| ... | .... | 636,000 | 4 | 53,000 | Francis | 75 | 83 | 80 | DEW | DEW | Elbow | Concrete | Head Ga | 46,625 | BG | 0.90 | 13.2 | 60 | CGE |
| | | | 2 | 8,000 | Francis | 180 | 83 | 80 | DEW | DEW | Elbow | Concrete | Head Ga | 7,200 | .... | 0.80 | 13.2 | 60 | CGE |
| 1 | 1939 | | 1 | 53,000 | Francis | 75 | 82 | 80 | DEW | DEW | Elbow | Concrete | Head Ga | 46,625 | BG | 0.80 | 13.8 | 60 | CGE |
| 2 | 1940 | | 2 | 53,000 | Francis | 75 | 83 | 80 | DEW | DEW | Elbow | Concrete | Head Ga | 43,886 | BG | 0.85 | 13.2 | 25 | CGE |
| ... | .... | 267,000 | 4 | 44,500 | Francis | 109.1 | 104–114 | 114 | DEW | W | Elbow | Plate St | Head Ga | 40,000 | AG | 0.90 | 11.0 | 60 | CGE |
| ... | .... | 95,000 | 4 | 19,000 | Prop | 150 | 56 | 56 | DEW | W | Elbow | Concrete | Head Ga | 18,000 | AG | 0.90 | 6.6 | 60 | CGE |
| 1 | 1939 | ..... | 1 | 19,000 | Prop | 150 | 56 | 56 | DEW | W | Elbow | Concrete | Head Ga | 18,000 | AG | 0.90 | 6.6 | 60 | CGE |
| ... | .... | 25,000 | 1 | 10,000 | Francis | 277 | 190 | 186 | MSI | W | Elbow | Plate St | Head Ga | 9,000 | BG | 0.90 | 11.0 | 60 | CGE |
| 1 | 1941 | ..... | 1 | 10,000 | Francis | 277 | 190 | 186 | MSI | W | Elbow | Plate St | Head Ga | 9,000 | BG | 0.90 | 11.0 | 60 | CGE |
| ... | .... | 24,700 | 1 | 12,350 | Francis | 257 | 205 | 200 | MSI | W | Elbow | Plate St | Head Ga | 10,000 | BG | 0.90 | 11.0 | 60 | CGE |
| ... | .... | 64,000 | 3 | 16,000 | Francis | 115.4 | 52–71 | 68 | DEW | W | Elbow | Concrete | Head Ga | 15,000 | BG | 0.80 | 13.8 | 25 | CWC |
| ... | .... | ..... | 2 | 26,000 | Francis | 100 | 72–67 | 70 | CAC | W | Elbow | Plate St | Head Ga | 17,500 | AG | 0.90 | 7.2 | 60 | CWC |
| ... | .... | 25,000 | 2 | 5,000 | Prop | 180 | 44–26 | 36 | MSI | W | [6] VS | Concrete | Head Ga | 4,500 | AG | 0.85 | 6.6 | 60 | OC |
| | | | 1 | 7,500 | Kaplan | 150 | 44–26 | 36 | MSI | W | [6] VS | Concrete | Head Ga | 6,000 | AG | 0.90 | 6.6 | 60 | CWC |
| | | | 1 | | | | | | | | Temporary installation | | ..... | 3,500 | AG | 0.80 | 6.9 | 60 | CWC |
| ... | .... | ..... | 1 | 7,500 | Francis | 257 | 158–150 | 148 | DEW | W | Elbow | Plate St | Head Ga | 6,250 | AG | 0.85 | 6.9 | 60 | SGE |
| ... | .... | 10,000 | 1 | 5,000 | Francis | 360 | 115 | 110 | CAC | .. | Elbow | Plate St | Head Ga | 4,200 | .... | 0.80 | 2.3 | 60 | CWC |
| ... | .... | ..... | 1 | 550 | ..... | 450 | 36 | 36 | .... | W | ..... | ..... | ..... | 450 | HS | 0.8 | 2.3 | 60 | CGE |
| ... | .... | ..... | 1 | 600 | Kaplan | 450 | 36 | 36 | MSI | W | ..... | ..... | Head Ga | 500 | .... | 0.80 | .... | 60 | CWC |
| ... | .... | ..... | 2 | 400 | Prop | 257 | 17 | 17 | DEW | W | Elbow | Concrete | Head Ga | 375 | .... | 0.80 | 2.3 | 60 | CWC |
| ... | .... | ..... | 1 | 216 | Prop | 90 | 5.4 | 5.4 | CAC | W | ..... | ..... | ..... | 187.5 | BG | 0.80 | 2.3 | 60 | CGE |
| ... | .... | ..... | 1 | ..... | ..... | 300 | .... | .... | ..... | .. | ..... | ..... | ..... | 438 | AG | 0.80 | 0.6 | 60 | CGE |
| ... | .... | ..... | 1 | ..... | ..... | 150 | .... | .... | .... | .. | ..... | ..... | ..... | 750 | AG | 0.80 | 0.6 | 60 | CGE |
| ... | .... | ..... | 1 | 380 | ..... | 600 | 65 | 62 | ..... | W | ..... | ..... | ..... | 312 | HS | 0.80 | 4.0 | 60 | EEC |
| ... | .... | ..... | 1 | 500 | Reif.[6] | 900 | 193 | 190 | DEW | W | Conical | Cast-Iron | Gate Valve | 450 | HS | 0.80 | 2.3 | 60 | SGE |
| ... | .... | ..... | 1 | ..... | ..... | 900 | .... | .... | ..... | .. | ..... | ..... | ..... | 3,250 | HS | 0.80 | 2.3 | 60 | SGE |
| ... | .... | 1,650 | 1 | 825 | Prop | 257 | 20 | 20 | DEW | .. | ..... | ..... | ..... | ..... | .... | .... | .... | .. | CWC |
| ... | .... | ..... | 1 | 2,500 | Prop | 225 | 32 | 32 | CAC | W | Elbow | Concrete | Head Ga | 2,040 | AG | 0.90 | 2.3 | 60 | CGE |
| ... | .... | ..... | 1 | 1,400 | Prop | 257 | 54 | 54 | CAC | W | Elbow | Concrete | ..... | 1,375 | HS | 0.80 | 2.3 | 60 | EEC |
| ... | .... | ..... | 1 | 12,000 | Francis | 250 | 130 | 124 | CAC | .. | ..... | ..... | Runner only | ..... | .... | .... | .... | .. | ..... |
| ... | .... | ..... | 1 | 750 | Francis | 900 | 170 | 166 | CAC | .. | ..... | ..... | ..... | ..... | .... | .... | .... | .. | CGE |
| ... | .... | ..... | 1 | 45,000 | Francis | 1,125 | .... | 120 | CAC | .. | ..... | ..... | Runner only | ..... | .... | .... | .... | .. | CWC |

[1] The term "New" applies to entirely new projects on sites that have not been developed previously. "Redevelop" indicates a project on a site that has been developed previously and may consist of new wheels and settings or an entirely new plant. Reconstruction indicates rebuilding of old equipment.

[2] AG indicates that the thrust bearing is above the generator rotor; BG, thrust bearing located below the rotor; HS, horizontal-shaft design.

[3] CGG, concrete-gravity type with control gates; M, masonry; EF, earth fill; AM, Amburgen; HR, hollow reinforced; P&G, piers and gates; REF, rolled earth fill; CG, concrete gravity; MA, multiple arch; GA, gravity arch; CA, concrete arch; RFC, rock filled timber crib.

[4] EHS, elbow with horizontal splitter plate; VS, vertical steel.

[5] Reiffenstein.

# Hydro Keeps Step With Steam in Both Kw and Kwhr

► BY THE END OF THIS YEAR, the U. S. will have installed or on order over 21,000,000 hp of hydroelectric capacity—about 25% of that necessary to develop all the potential water power in this country.

The tables on the four preceding pages give detailed data on all installations built or in process of construction since January 1, 1939, in the U. S. and Canada. By December, 90 of these projects in America will have added approximately 1,400,000 hp and will have another 1,750,000 hp due for operation in 1941 and 1942.

Although the big slice of new water-power capacity is Federal, many utility and industrial companies are building new plants, adding new units to existing plants or rebuilding old ones. Central Maine Power Co recently unwrapped its new Williams plant, which houses one 10,250-hp unit and has space for another similar turbine, and added a 34,000 hp unit to its Wyman plant.

### New Utility Units

Bangor Hydro-Electric Co revamped two of its old plants and added 10,000 hp capacity. The Safe Harbor Water Power Corp is installing a seventh 42,500-hp machine. Early last year, Appalachian Electric Power Co put a new plant (four 26,000-hp units) on the line. And in the Far West, Pacific Gas & Electric Co is rebuilding three of its older plants and adding new capacity.

Two months ago the Federal Power Commission granted permission to Nantahala Power & Light Co to build two hydro projects on the Little Tennessee River at Nantahala and Glenville, N. C. Nantahala will have a 60,000-hp turbine operating under 999-ft head, Glenville a 30,000-hp unit under 1215-ft head; these two plants will have the highest heads east of the Rockies. Construction contracts have already been let.

The table lists all government projects and shows existing as well as future capacity. (For geographical location of all Federal hydro projects, see map on page 80). This tabulation includes 38 plants designed for an ultimate capacity of 10,000,000 hp, equivalent to more than 50% of the total installed U. S. hydro capacity. At present, however, slightly over 2,500,000 hp has been installed and a little less than 2,500,000 is on order.

All the large government water-power projects in the Pacific Coast area, with the exception of Bonneville, are essentially water-supply and river-regulation undertakings from which large amounts of power can be generated. Much of this energy, however, will be required to pump water for municipal water supply and irrigation. Boulder Dam, to which all hands can point with pride, has accomplished all that was expected of it and more. Planned for 1,835,000-hp capacity, it will have installed by the end of 1940 a total of 1,212,000-hp, making it the largest-capacity station (steam or hydro) in the world.

Grand Coulee, the largest Federal project, is designed for an ultimate capacity of 2,742,000 hp in eighteen 150,000-hp main units and three 14,000-hp service units at a maximum head of 360 ft. Three main and two service turbines now being installed are scheduled for operation next year. The dam, incidentally, is the largest (volume) man-made structure in the world. Irrigation-water pumping units will require 800,000 horsepower.

### Shasta Project

Part of the power from the Shasta development now under construction on the Sacramento River in California will be used for pumping irrigation water. Plans call for five 103,000-hp units, four of which are on order and scheduled for initial operation in 1943. The Shasta Dam ranks next in size to Grand Coulee and will store 4,000,000 acre-ft.

So much has been said about government hydro plants and their size that the question naturally arises: What effect have they had on steam-plant construction? The curves, Figs. 1 and 2, give the answer: Since 1920, the relationship between kwhr generated by steam and by hydro has remained practically constant. Also very interesting is the fact that in spite of all the water-power development by Federal agencies, hydroelectric capacity increased more rapidly before 1932 under private initiative than it has since with extensive government building.

For nine years, 1923 through 1931, water-power capacity was boosted by approximately 7,000,000 hp, at an average rate of about 800,000 hp per year.

### THE FACTS IN BRIEF

**Percent of total utility kwhr generated by water-power projects has remained the same for 20 years (see Fig. 2)**

**Hydro capacity increased more rapidly before 1932 under private initiative than it has since with extensive Federal aid**

**Except for the Tennessee Valley, government hydro plays a small part in supplying power east of the Mississippi River**

**In practically every case today, new steam capacity will give cheaper delivered power than new hydro**

By comparison (omit the four depression years, 1932 through 1935, in fairness), about 3,000,000 hp was installed during the five years, 1936 through 1940, an average rate of 600,000 hp per year. And for 20 years, the division between hydro- and steam-generating capacity in both private and government utility plants has remained practically constant. Hydro capacity in 1920 was 25.3% of the total, in 1939, 28.3%.

Total power generated by private and government utilities from 1920 through 1939, and the per cent of total power generated by hydro plants, are shown in Fig. 2. Significant is the fact that in 1920 hydro produced 36.8% of the total kwhr, while in 1939 33.8% of the total was generated by hydro, a loss of 3 points or 8%.

Last year, however, was marked by subnormal rainfall accompanied by abnormal increase in total power generated, which account for the low per cent of hydro generation. Increases or decreases in total annual load and rainfall influence the dotted-line curve, Fig. 2, and are responsible for most of the peaks and valleys in it.

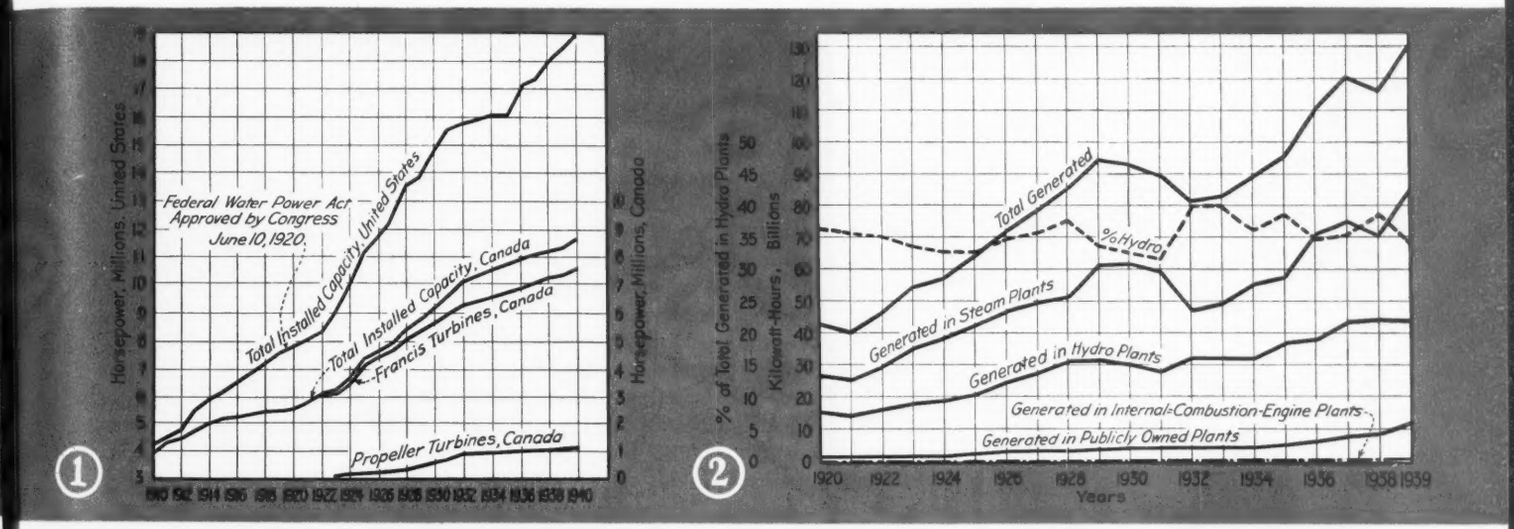
Geographical distribution of government hydro plants is such that they can have only meagre influence on steam-

plant construction, except possibly in the Tennessee Valley. Of the total ultimate 10,000,000 hp planned for Federal water-power projects, energy generated by 60% of this capacity is in Pacific Coast States or in plants which will supply power to Pacific Coast states. Include the Mountain states and you have about 70% of the total government hydro capacity in the Far West, normally served by hydro.

West of the Mississippi dwells 30% of the population of the U. S. on 70% of the country's land area. This region contains 75% of the government hydro capacity, leaving 25% to serve 75% of the population east of Old Man River. A large part of this capacity is concentrated along the Tennessee River, in TVA plants, so that most of the East's industrial area is outside the influence of government hydro plants.

Two factors now favor the construction of steam plants for new capacity. First, efficiency and construction cost of steam plants have improved to the point where it is extremely difficult for new hydro to compete on an economic basis. Second, the Federal Power Commission's attitude towards private utilities has been such as to discourage their development of hydro projects.

Most water-power plants have to be supplemented by steam to take over load during low-water periods and for standby service. Even TVA, with its 60,000-kw steam plant at Muscle Shoals and about 200,000 kw of steam capacity inherited when it took over the Tennessee Electric Co, recently asked Congress for funds to build a new 120,000-kw steam station.




## HYDROELECTRIC PROJECTS BEING BUILT AND OPERATED BY GOVERNMENTAL AGENCIES

| Government Agency | Project | State | River | Ultimate Cap., Hp | Initial Cap. Hp | Installed Hp | On Order Hp |
|---|---|---|---|---|---|---|---|
| U. S. Bureau of Reclamation | Grand Coulee | Wash. | Columbia | 2,742,000 | 478,000 | ..... | 478,000 |
| U. S. Engineer Corps | Booneville | Wash. | Columbia | 729,000 | 137,000 | 285,000 | 148,000 |
| U. S. Bureau of Reclamation | Shasta | Calif. | Sacramento | 522,000 | 419,000 | ..... | 419,000 |
| Imperial Irrigation Dist | Drop No. 3 | Calif. | All Am. Canal | 15,000 | 7,500 | 7,500 | ..... |
| Imperial Irrigation Dist | Drop No. 4 | Calif. | All Am. Canal | 26,600 | 13,300 | 13,300 | ..... |
| U. S. Bureau of Reclamation | Parker Dam | Ariz.&Calif. | Colorado | 160,000 | 120,000 | ..... | 120,000 |
| U. S. Bureau of Reclamation | Boulder Dam | Ariz.&Nev. | Colorado | 1,835,000 | 522,000 | 1,212,000 | 115,000 |
| U. S. Bureau of Reclamation | Elephant Butte | N. M. | Rio Grande | 34,500 | 34,500 | 34,500 | ..... |
| U. S. Bureau of Reclamation | Seminoe | Wyo. | N. Platte | 45,000 | 45,000 | 45,000 | ..... |
| U. S. Bureau of Reclamation | Green Mountain | Colo. | Blue | 30,000 | 30,000 | ..... | 30,000 |
| U. S. Bureau of Reclamation | Colo.–Big Thompson | Colo. | Colo.–Big Thompson | 135,000 | ..... | ..... | ..... |
| U. S. Bureau of Reclamation | Minidoka | Idaho | Snake | 26,000 | 9,000 | 17,800 | ..... |
| U. S. Engineer Corps | Fort Peck | Mont. | Missouri | 150,000 | 70,000 | ..... | 70,000 |
| Platte Valley Pub Pr & Irr Dist | Sutherland | Neb. | N Platte | 35,000 | 35,000 | 35,000 | ..... |
| Loup River Public Power Dist | Monroe | Neb. | Loup | 9,600 | 9,600 | 9,600 | ..... |
| | Columbus | Neb. | Loup | 54,000 | 54,000 | 54,000 | ..... |
| Central Neb Pub Pr & Irr Dist | Jeffery Canyon | Neb. | Platte | 26,000 | 26,000 | ..... | 26,000 |
| | Johnson No. 1 | Neb. | Platte | 26,000 | 26,000 | ..... | 26,000 |
| | Johnson No. 2 | Neb. | Platte | 50,000 | 25,000 | ..... | 25,000 |
| Grand River Dam Authority | Pensacola Dam | Okla. | Grand | 100,000 | 80,000 | ..... | 80,000 |
| Lower Colorado River Auth | Buchanan Dam | Texas | Colorado | 51,900 | 34,600 | 34,600 | ..... |
| | Tom Miller | Texas | Colorado | 20,000 | 20,000 | 20,000 | ..... |
| | Inks Dam | Texas | Colorado | 16,000 | 16,000 | 16,000 | ..... |
| | Marshall Ford | Texas | Colorado | 90,000 | 90,000 | ..... | 90,000 |
| Brazos Riv Conser & Reclam Dist | Possum Kingdom | Texas | Brazos | 51,000 | 34,000 | 34,000 | ..... |
| Tennessee Valley Authority | Kentucky | Tenn. | Tennessee | 220,000 | ..... | ..... | ..... |
| | Pickwick | Tenn. | Tennessee | 330,000 | 110,000 | 110,000 | 55,000 |
| | Wilson– | Ala. | Tennessee | 610,000 | 260,000 | 260,000 | 70,000 |
| | Wheeler | Ala. | Tennessee | 360,000 | 90,000 | 90,000 | 90,000 |
| | Guntersville | Ala. | Tennessee | 136,000 | 102,000 | 102,000 | ..... |
| | Hales Bar | Tenn. | Tennessee | 44,000 | 44,000 | 44,000 | ..... |
| | Chickamauga | Tenn. | Tennessee | 144,000 | 108,000 | 108,000 | ..... |
| | Watts Bar | Tenn. | Tennessee | 210,000 | 126,000 | ..... | 126,000 |
| | Fort Loudoun | Tenn. | Tennessee | 140,000 | 105,000 | ..... | ..... |
| | Hiwassee | Tenn. | Hiwassee | 160,000 | 80,000 | 80,000 | ..... |
| | Norris | Tenn. | Clinch | 132,000 | 132,000 | 132,000 | ..... |
| S Carolina Pub Serv Auth | Santee-Cooper | S.C. | Santee | 213,000 | 173,300 | ..... | 173,300 |
| Greenwood County Board of Comm | Buzzards | S.C. | Saluda | 30,000 | 22,200 | 22,200 | ..... |

# Location and Capacity of All Government Hydro Projects

**LEGEND**

BR – U.S. Bureau of Reclamation
US – U.S. Engineer Corps
II – Imperial Irrigation District
PV – Platte-Valley Public Power & Irrigation District
LR – Loup-River Public Power District
CN – Central-Nebraska Public Power & Irrigation District
GD – Grand-River Dam Authority
LC – Lower-Colorado River Authority
BD – Brazos-River Conservation & Reclamation District

**TVA PROJECTS**

A – Kentucky, 220,000 Hp Ultimate; None on order
B – Pickwick, 110,000 Hp Installed; 55,000 Hp on order; 330,000 Hp Ult.
C – Wilson, 260,000 Hp Installed; 70,000 Hp on order; 610,000 Hp Ult.
D – Wheeler, 90,000 Hp Installed; 90,000 Hp on order; 360,000 Hp Ult.
E – Guntersville, 102,000 Hp Installed; 136,000 Hp Ultimate
F – Hales Bar, 44,000 Hp Installed
G – Chickamauga, 108,000 Hp Installed; 144,000 Hp Ultimate
H – Hiawassee, 80,000 Hp Installed; 160,000 Hp Ultimate
I – Watts Bar, 126,000 Hp on order; 210,000 Hp Ultimate
J – Fort Loudoun, Approximate 140,000 Ultimate; None on order
K – Norris, 132,000 Hp Installed; 132,000 Ultimate

# Up-to-the-Minute Air Conditioning for the Southeast's Oldest Bank

***New Freon-11 turbo-compressor unit provides 350 tons of refrigeration for complete air conditioning of the 15-story First National Bank of Atlanta Building***

Fig. 1—Atlanta's First National Bank Bldg rises 15 stories, all air-conditioned

▶ When Scarlett O'Hara, in "Gone with the Wind," draws a check on the First National Bank of Atlanta, it isn't just a Hollywood touch—the First National, oldest bank in the Southeast, actually was an Atlanta landmark in Civil War days. Today it's still a landmark—and not the least of the reasons is its completely conditioned 15-story building, served by a new Freon-11 turbo-compressor unit.

Back about 10 years ago, the building management took a step toward conditioning by installing 5 ventilating systems supplying washed air to: (1) the main banking area, (2) the 2nd, 3rd, and 4th floors, (3) the 5th, 6th, and 7th floors, (4) the Savings Dept on the ground floor, and (5) the Safety Deposit Dept in the building basement.

The recently completed installation, designed by Newcomb and Boyd, of Atlanta, and furnished and installed by the York Ice Machinery Corp, comprises a single 350-ton turbo-compressor unit supplying chilled water to two main circuits, one feeding three modernized washers, the other feeding 10 unit conditioners with finned-coil surface. In winter, district steam heats water for circulation to the unit conditioners; this tempers incoming fresh air and supplements existing steam coils on the washers and a complete steam-heating system with recessed convectors and conventional radiation.

The three washers retained from the former five have been thoroughly revamped by the addition of face and bypass dampers, American renewable steel-wool filters, and new mist-spray nozzles for winter humidification. The first of the three serves the main banking room, the major portion of which was provided with Anemostats replacing existing grilles in a furred ceiling. The area occupied by officers of the bank receives air supply from grilles in false beams serving as ducts. Return grilles are in false columns.

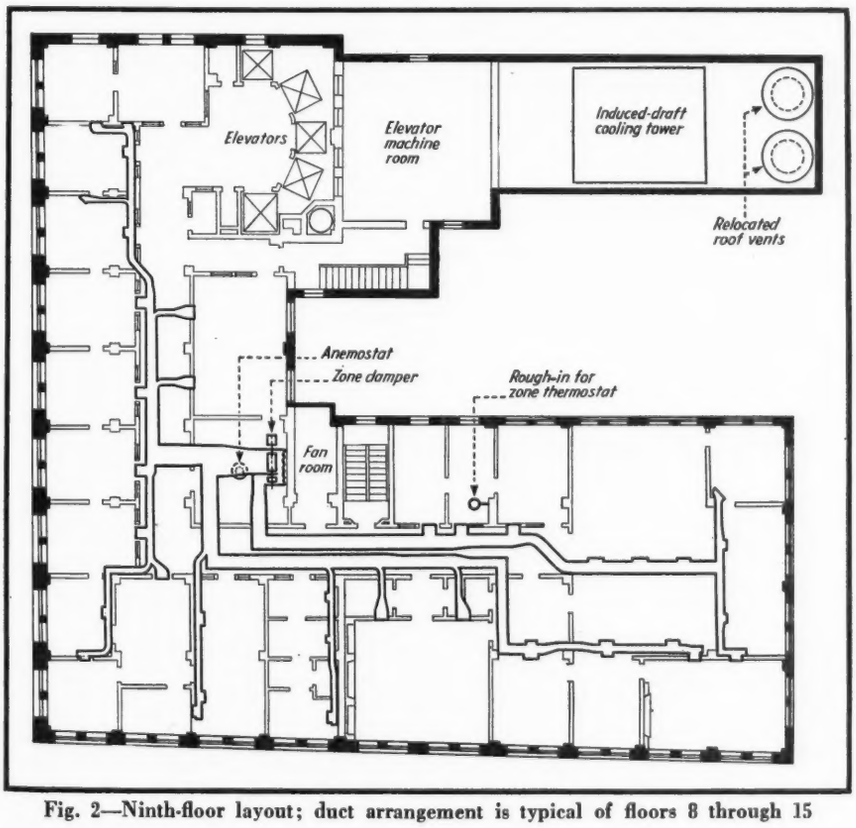



Fig. 2—Ninth-floor layout; duct arrangement is typical of floors 8 through 15

### *Used Existing Ducts*

The second washer supplies the 2nd, 3rd, and 4th floors. On the 2nd floor, existing ducts running above a furred ceiling in the central area supplied private offices and service rooms along outside walls. Existing return grilles were also utilized. The 3rd and 4th floors consist of open office space for the Bank's bookkeeping and clerical departments. These floors also had existing

ducts, behind a furred ceiling, supplying grilles along the outside edges of the central section. Addition of Anemostats under the furred ceiling produced better distribution in the central area.

The third washer serves the 5th, 6th, and 7th floors, which constitute rental space. Here again, ducts in a furred central section of the ceiling supplied grilles opening into individual office spaces along the outside walls. Addition of Anemostats in the central area made this space more comfortable and therefore more valuable from a rental standpoint. Return grilles in the doors take care of the individual offices, and ceiling grilles in the central area connect to existing return ducts.

### *Upper-Floor Layout*

The remaining floors, all rental space, resemble each other closely in general layout (Fig. 2). Furred corridor ceilings provide space for supply ducts. Door grilles admit return air to the corridors, which serve as return ducts. Machinery rooms on the 8th and 9th floors house fresh-air and return intakes, banks of American renewable steel-wool filters, and York "packaged" conditioning units comprising fan, finned coils, humidifying sprays, and face and bypass dampers. Similar machinery rooms on the 11th, 13th, and 15th floors each contain two units, one handling the machinery-room floor and the other the floor below.

A machinery room in the sub-basement, equipped with two units, serves the Safety Deposit Dept and the Savings Dept, formerly tied-in on the old washer system.

To provide "personalized" conditioning and, at the same time, to avoid constant manipulation by occupants, air supply to individual spaces can be registered in two ways. Behind each supply grille, a damper-deflector controls the maximum volume of air going to that grille. These damper-deflectors can be adjusted, by authorized persons, through small fixtures in the corridor ceiling. Occupants can regulate the standard damper built into each grille and so can secure any portion of the maximum flow diverted to the grille by the damper-deflector. All Anemostats except those in the main banking area are fitted with Anemotrols which can be adjusted by the occupants.

The basic setup of all machinery rooms includes a plenum into which return air flows through door grilles or dampered openings. Fresh air enters through louvre dampers. The mixture of fresh and return air passes through the filter bank to the unit or washer, as the case may be. The face and bypass dampers divide this air stream so that a part goes through the washer sprays or finned coils and the remainder goes through the bypass. By altering these proportions, the temperature and humidity of the supply air can be controlled.

Summer-winter thermostats, connected to a master compensating unit outdoors, control the face and bypass dampers through Johnson Service Co pneumatic damper motors of new design. Normal setting of the indoor instruments is 75 F, but the master thermostat compensates this through a range of 75 to 80 F as outdoor temperature varies from 75 to 95 F. On floors 8-15, room thermostats are mounted in the corridors; for floors 5, 6 and 7, a single insertion instrument in the 6th-floor return duct does the job. Similarly, an insertion thermostat in the 3rd-floor return controls 2nd, 3rd, and 4th floors. The banking room has an individual unit in the return duct and the Safety Deposit and Savings Depts each has a single thermostat in the conditioned space.

Modulating insertion thermostats in the discharge of washers and coils control automatic water-supply valves to regulate flow and so maintain a constant air temperature off the coils or washer. This control, in conjunction with the face and bypass damper controls, gives more complete regulation of temperature and humidity.

In each machinery room, the fresh-air intake is fitted with louvre dampers of sufficient capacity to supply the system with 100% fresh air. One louvre is so arranged that the pneumatic damper motor opens it automatically when the chilled water starts to flow and shuts it when the flow stops. The remaining dampers are lever operated and interlocked with the automatic damper so that all can be adjusted manually when no chilled water is flowing. This permits operating the building on 100% fresh air on Spring and Autumn days when neither heating or cooling is required. Each machinery room is also equipped with a thermostatic relay, near the filter bank, designed to shut down the fan motor if the temperature becomes excessively high.

### *Zoning Control*

A zoning control takes care of differences in cooling load caused by the changing position of the sun. On the 8th to 15th floors, three supply ducts serve the north, east, and west areas of the building respectively (Fig. 2). In the fan rooms, where these ducts run side by side, a set of dampers is provided, with one damper blade in each duct, but with all blades mounted on a single shaft running through the ducts. A thermostat in the west area of the 8th floor controls all the shafts. Similar thermostat locations are roughed in on each of the other floors, in the event it should prove desirable to shift the position of the instrument.

With the sun on the east side in the morning, the west area comes to temperature more quickly and the thermostate adjusts the damper shafts to close

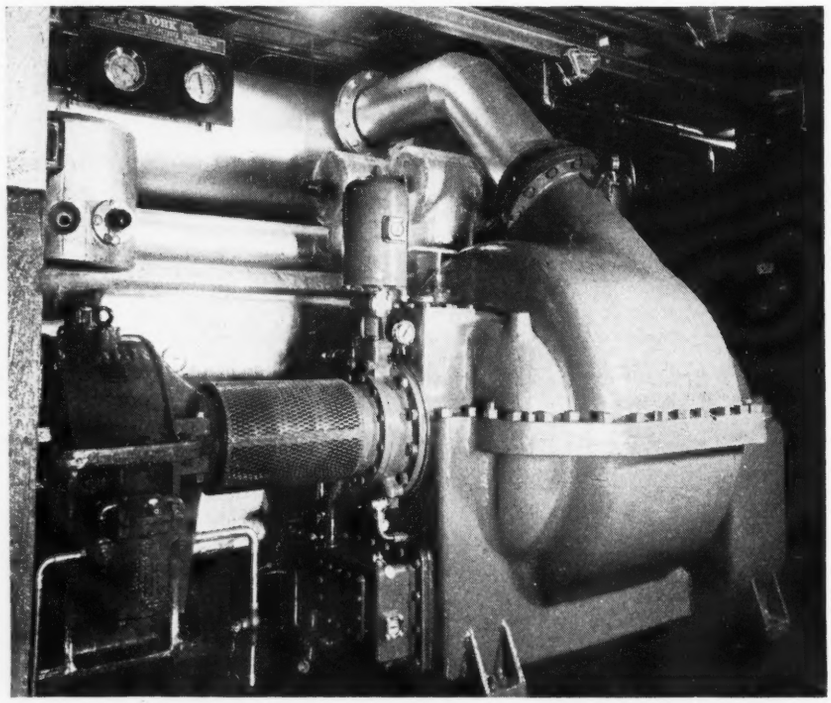



Fig. 3—Motor-driven turbo-compressor with condenser and water cooler at rear

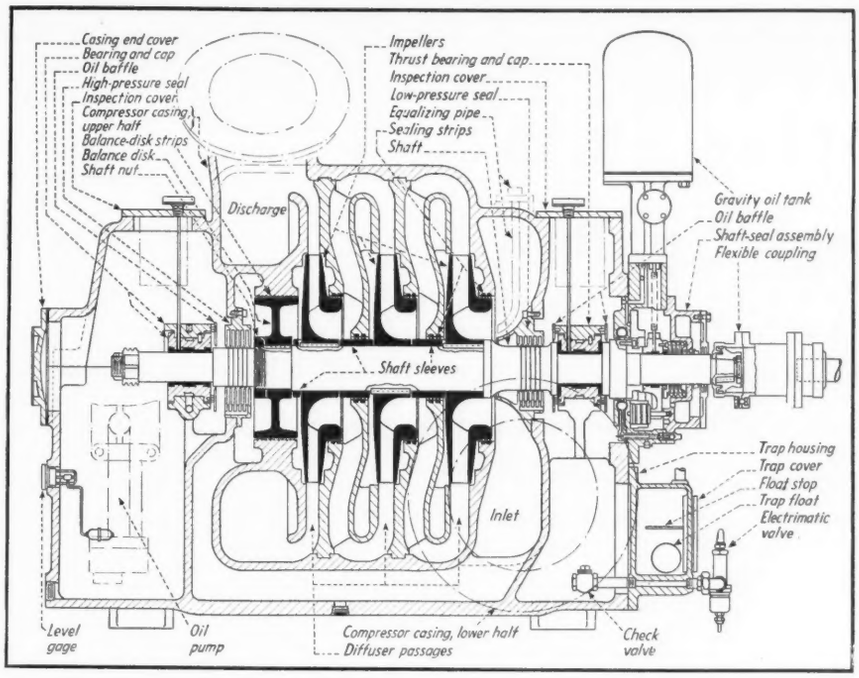



**Fig. 4—Construction details of compressor**

off the west ducts partially and to furnish more air, proportionately, to the north and east sides. In the afternoon, when the sun shifts to the west side, the thermostat readjusts the damper, shutting down on the north and east ducts and giving the west ducts more than their share.

The 3rd to 7th floors have only two zones. A thermostat in the east zone controls a splitter damper and so distributes the air volume to meet changing sun loads. The 2nd floor, the banking area, Safety Deposit and Savings Depts have no western exposure and so need no zoning. A few rooms throughout the building, which are used only occasionally, are zoned so that they may be shut off when not in use.

### *Turbo-Compressor*

The flexibility of the refrigeration equipment selected made it possible to fit it into space in the building basement made available by removal of an old heating boiler and equipment associated with the former ventilating system. The heart of the refrigerating plant is the York-Allis-Chalmers turbo-compressor unit, which is similar in general design to turbo-compressors developed in Europe by the Brown-Boveri Co and applied in units as large as 2640 tons. This 3-stage machine (Fig. 3), manufactured by Allis-Chalmers under license, employs Freon-11 as refrigerant. Intercoolers between stages remove part of the heat of compression and so reduce the horsepower required per ton of refrigeration.

The compressor itself consists of a 2-part, horizontally split casing with the necessary diffuser passages (Fig. 4). The forged-steel shaft carries cast-alloy enclosed impellers with backward-curved blades; a balance disk, with suction pressure on one side and discharge pressure on the other, counteracts unbalanced axial thrust. Two pressure-lubricated babbitt-lined sleeve bearings support the rotor and provide axial starting-thrust surface for the rotor shaft collars. A shaft-driven pump supplies lubricating oil during operation while an auxiliary pump takes care of the startup period.

Labyrinth seals on the impeller hubs and on the balance disk prevent leakage of refrigerant between stages and into non-compression areas. During operation, lubricating oil under pressure seals the main shaft, there being no rubbing surfaces to wear. To secure tight closure when the unit is shut down, a spring-operated sylphon diaphragm forces the non-rotating sealing surface against the shaft collar. A Neoprene tube surrounding the shaft on the compressor side of the sealing assembly can be inflated with air to form a tight-fitting collar which will permit inspection or removal of the shaft-sealing assembly without loss of refrigerant.

A Westinghouse slip-ring motor drives the compressor through a 2.05-to-1 Falk speed-increasing gear, giving a compressor speed of about 3500 rpm at full load. By a series of resistances, motor speed can be varied over a range of eight steps, giving close capacity control. A manually operated butterfly damper on the compressor suction inlet reduces motor starting load and can be used to give additional capacity control if needed. Operators regulate motor speed manually, in accordance with temperature of water leaving the cooler.

Refrigerant gas leaving the compressor enters the York horizontal, multipass, shell-and-tube condenser. An 1100-gpm Allis-Chalmers pump circulates condenser water through a closed system to a Marley induced-draft cooling tower on the 8th floor penthouse roof (Fig. 2). The tower has a casing and inlet air louvres of clear-heart California redwood and a redwood filling. Centrifugal, low-pressure, non-clog nozzles distribute water over the filling; a 12-blade, 114-in. propeller fan, driven by a 15-hp motor, supplies necessary air circulation.

In the York shell-and-tube water cooler, a perforated pan above the tubes distributes refrigerant over the entire surface and a pump lifts the liquid from the bottom of the cooler to the pan. This arrangement reduces the refrigerant charge required and avoids the possibility of frozen tubes by keeping the refrigerant level below the tubes. Two Allis-Chalmers pumps take chilled water from the cooler and distribute it through two main circuits supplying washers and unit conditioners.

### *Winter Operation*

For winter operation, an instantaneous tubular water heater, supplied with purchased steam, provides tempered water for circulation to the finned coils of the conditioners. Existing steam reheating coils on the washers temper winter air. Humidostats next to the winter-summer thermostats control the valves regulating the water supply to spray nozzles for winter humidification.

To centralize over-all control of the system, a panel board in the engine room carries transfer and summer-winter relays and a Brown remote-reading selective thermometer. The relay switches, 6 in number, provide for changing from automatic to neutral on the zoning dampers; for closing, opening, or putting on automatic control the minimum fresh-air damper; and for shifting from summer to winter operation on the face and bypass dampers, on the humidity control, and on the hot-water control.

The electrical resistance thermometer carries a 20-point selector switch by which temperature readings can be made at the following stations: Savings Dept, 2nd to 15th floors, Safety Deposit Dept, banking area and outside. For the latter two stations only, both dry-bulb and wet-bulb readings are available.

# Divided Pumping Units Improve Output Control

***A Peterson, chief engineer, Pump and Compressor Dept, De Laval Steam Turbine Co, shows how minimum operating costs are obtained by dividing centrifugal pumps and controlling speed of one section only, when discharge must be regulated***

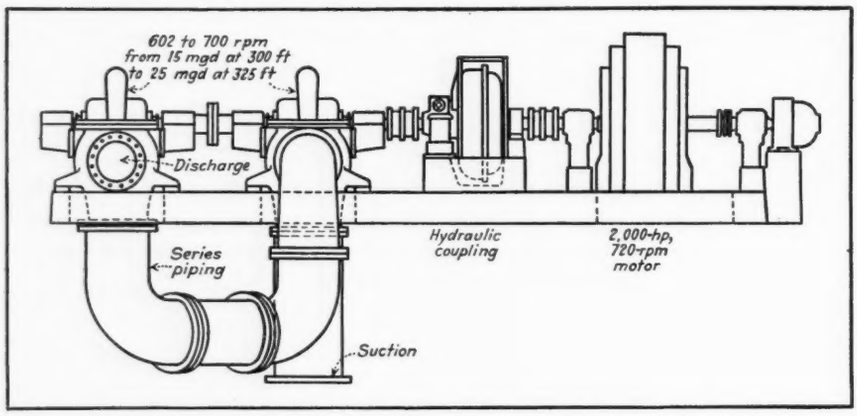



**Fig. 1—Hydraulic coupling between driving motor and two pumps in series to regulate discharge and head. Loss at full power is twice as much as set-up of Fig. 2.**

▶ To vary the output of a centrifugal pumping unit, consisting of two or more pumps in series or in parallel, sufficient control of discharge can be obtained generally by adjusting the speed of one pump through a variable-speed coupling. This arrangement permits the use of a smaller lower-cost coupling and also reduces power losses. For instance, with two identical pumps connected in series, Fig. 2, a hydraulic coupling to adjust the speed of one pump need transmit one-half the power (820 hp) required for the two (1640 hp), Fig. 1. At full power the coupling, Fig. 2, will have about one-half the losses of that in Fig. 1 regulating the speed of the two pumps. In this case, the loss at full power will be only 34 hp (Fig. 2) instead of 68 hp, Fig. 1.

Curve *A*, Fig. 3, shows the output of the motor when the pumps, Figs. 1 and 2, operate at constant speed and their output is controlled by throttling. At a pumping rate of 13,900 gpm (20 mgd), the motor has to develop 1557 hp. If the discharge is regulated by adjusting speed of the two pumps, Fig. 1, then curve *B* shows the power developed by the motor, which is 1400 hp at 13,900 gpm.

When discharge is regulated by adjusting the speed of one pump only, horsepower developed by the motor will be represented by curve *C*, Fig. 3. At 13,900 gpm, motor power is 1345 hp or 1557−1345 = 212 hp less than constant-speed operation and 1400−1345 =55 hp less than regulating the speed of both pumps. The shaded area between curves *A* and *B* represents the power saving obtained by adjusting the speed of both pumps, compared to throttling the discharge at constant speed. The shaded area between curves *B* and *C* represents the additional saving obtained by controlling pump discharge through a coupling between the pumps.

With two or three pumps in series, the total maximum operating head does not have to be divided equally between the pumps. Depending upon the change in head and capacity required, in many cases it will be more economical to design the adjustable-speed element of the unit for a head less than a half or a third of the total head. This will give a still lower coupling cost and lower losses in it. Even where single-stage pumps would ordinarily be used, as for heads between 200 and 250 ft, which are rather common in waterworks plants, it may be preferable to design the unit with two pumps in series.

### *Feed Pumps*

Boiler-feed pumps lend themselves to interposing a variable-speed coupling between two pumps operating in series. The primary pump driven through the variable-speed coupling is designed to develop at minimum speed the lowest pressure consistent with the maximum speed reduction through the coupling, in line with minimum suction pressure required for the secondary pump. In some cases this pressure may be appreciably higher than necessary for the primary pump because of heaters connected between the two pumps.

Fig. 4 shows the head-delivery and power-characteristic curves for a high-pressure boiler-feed pump. Curve $A_1$ is the head-delivery characteristic of the pump at constant speed and *A* the corresponding horsepower curve. Curve $B_1$

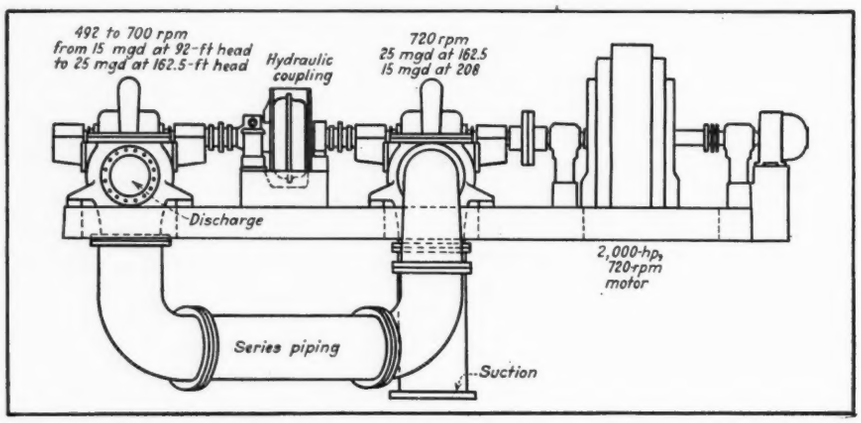



**Fig. 2—Hydraulic coupling between two pumps in series regulates output of both**

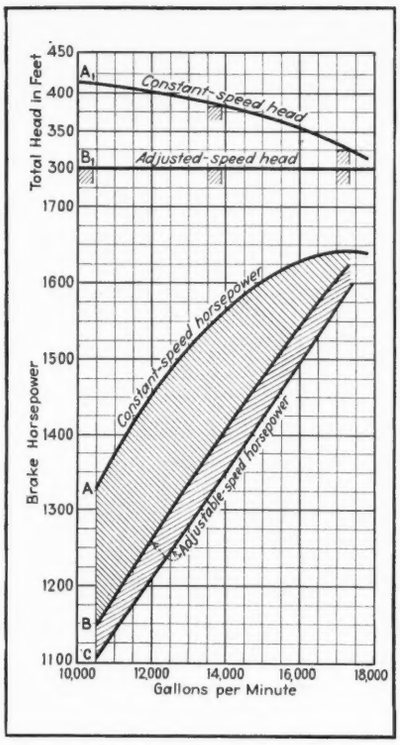



**Fig. 3—Shaded areas show power saving by adjusting speed of the pumps, Figs. 1 and 2, compared to constant speed**

is the actual system head-capacity to which the pump can be adjusted by running it at different speeds. Curve *B* represents horsepower input to the pump through a variable-speed coupling which must transmit a maximum of 856 hp. Curve *C* is power input for a pumping unit to meet the condition of $B_1$, but consisting of a primary and a secondary pump in series with the variable-speed coupling between them. The variable-speed primary pump is designed to develop 35 lb per sq in. when operating at a minimum speed of 530 rpm. At maximum speed of 1700 rpm for this pump, with the secondary pump running at motor speed of 1750 rpm, the unit delivers 750 gpm. Under these conditions the primary pump develops 330 lb per sq in. of the total 1275 and requires 219 of a total input of 862 hp.

### *Difference in Hp*

If the same pressure and delivery were developed by driving all pump stages through the coupling, the motor would deliver 882 hp to the coupling. With 856 hp input to the pump, the loss in the coupling is 882—856=36 hp. When the coupling is interposed between the two pumps, it transmits 219 hp with a loss of only 9 hp, a saving of 36—9=27 hp. Besides, a coupling to transmit 219 hp will cost about 66% as much as one that can transmit 856 hp.

Curve *C* represents the power input to the series pumping unit over its operating range and the shaded area shows the power saving compared to adjusting the speed of all pump stages. For example, at 500 gpm delivery direct drive of all stages requires 690 hp motor output, curve *A*. Variable-speed coupling drive of all stages totals 637 hp motor output, curve *B*. Direct drive of the secondary pump and variable-speed-coupling drive of the primary pump requires only 618 hp.

### *Pumps in Parallel*

Connecting two pumps in parallel to be driven from one motor is not a very common practice and, offhand, such an arrangement may appear more expensive than a single pump. However, one should remember that in most cases it is possible to operate such a unit at about 40% higher speed, which may reduce the cost of the motor materially. Thus, the cost of the two high-speed pumps may not be much greater than that of the single slow-speed pump.

Fig. 4 shows the power and head characteristic curves for two identical pumps in parallel, each rated 30 mgd at 40-ft head and driven by one motor. Curve *A* represents power input to the pumps operating at constant speed. Power output of the motor when adjusting the speed of both pumps through a variable-speed coupling to maintain a constant head of 40 ft is given by curve *B*. Curve *C* shows the power output of the motor when the variable-speed coupling is installed to adjust the speed of one pump only.

For example, at 40-mgd discharge, motor output at constant-pump speed is 435 hp. When speed of both pumps is adjusted to give 40 mgd at 40-ft head, motor output drops to 395 hp and when speed of one pump only is adjusted the motor output is 372 hp. This amounts to a difference in power input of 395 — 372 = 23 hp.

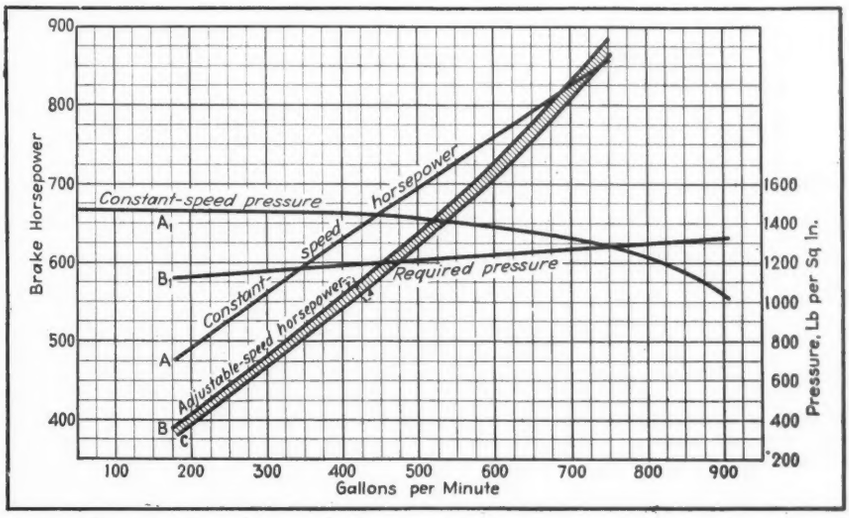



**Fig. 4—Characteristics of boiler-feed pump operating at constant and adjusted speed**

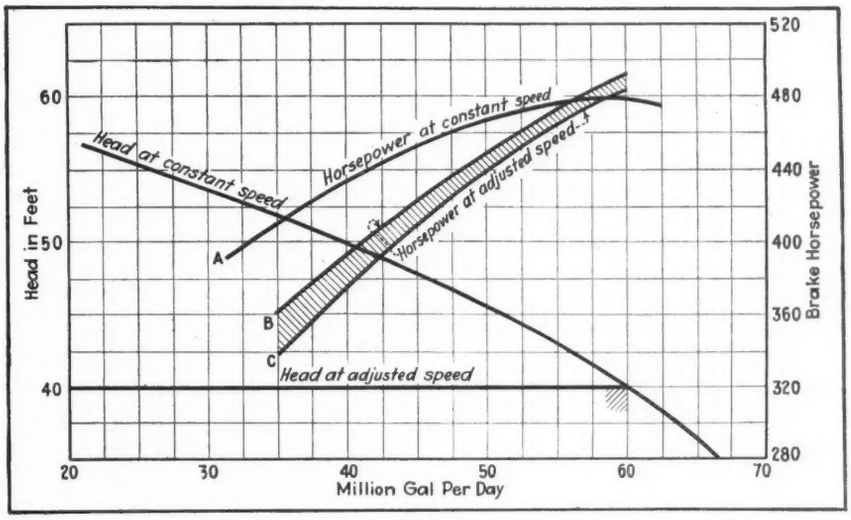



**Fig. 5—Characteristic curves of two low-head pumps operating in parallel at constant and adjusted speed**

# Servomotors Control Double-Extraction

***The increasingly useful extraction turbine owes its satisfactory performance to governing mechanism and controls that are still rather mysterious to most of us. O N Bryant, Westinghouse Electric & Mfg Co, explains the workings of an oil relay system that controls extraction pressures***

▶ A DOUBLE-EXTRACTION TURBINE is essentially three turbines in one casing having one shaft and one load. Each turbine has its own inlet valve or valves controlled in such a manner that the combined power output equals the required load with constant steam pressure in the extraction lines, even when amount of extracted steam varies.

Since the incremental steam rate (added lb per hr per added kw) for each of the three turbine elements remains very nearly proportional to load over a wide range of flow and load, control devices can be quite simple and yet give nearly ideal results. If the reader will bear in mind that each of the three turbine elements has a governor and inlet valve, and that each governor is influenced by (1) speed, (2) pressure at higher extraction point, and (3) pressure at lower extraction point, the following explanation will be quite clear.

### *Three Turbines in One*

Fig. 1 shows diagrammatically the flow path of steam through a double-extraction turbine. In an actual machine, the three turbine elements are all in one cylinder separated by diaphragms. In an actual turbine, governors and control valves 1, 2, and 3 may be in the form of steam chests having several valves feeding separate nozzle groups, or may be in the form of slide valves or grid valves having steam flow ports that open in sequence to supply steam to several nozzle groups attached to the interstage diaphragm.

High-pressure steam quantity $Q_1$, medium-pressure $Q_2$, and low-pressure $Q_3$, are assumed not to include the small amount of steam required to run the unit at zero load. Hence, the power developed in each of the three turbine sections will vary nearly in proportion to the change in individual flows. Each turbine element develops power equal to the flow in that section divided by the incremental steam rate of the section. The whole turbine load is the sum of the three parts.

This relation means that any change in the total power will equal the sum of the changes in power produced in each section. Three variations in conditions of operation should be considered:

(a) a change in the total power with no change in extraction.

(b) a change in the rate of extraction at the higher extraction point with no change in total power or of low-pressure extraction.

(c) a change in rate of extraction at the lower extraction point with no change in total power or high-pressure extraction.

Any other condition represents some combination of these three.

In the first case, any change in high-pressure-steam admission must cause an equal change in flow through medium- and low-pressure governor valves. Any change in turbine speed should cause all three governors to change flows through their respective valves by the same amount. Any variation in the speed-changer setting should affect all three governors equally.

For the second case, an increase in the rate of extraction at the higher point requires admission of more high-pressure steam, $Q_1$, while $Q_2$ and $Q_3$ must decrease equally by an amount just sufficient to maintain a constant total output of power.

An increase in the rate of extraction at the lower point requires flows $Q_1$ and $Q_2$ to increase equally, while $Q_3$ decreases enough to keep power output constant.

For all three cases, or any combination of them, no change can occur in any quantity without requiring a change in the opposite direction in either or both of the other quantities.

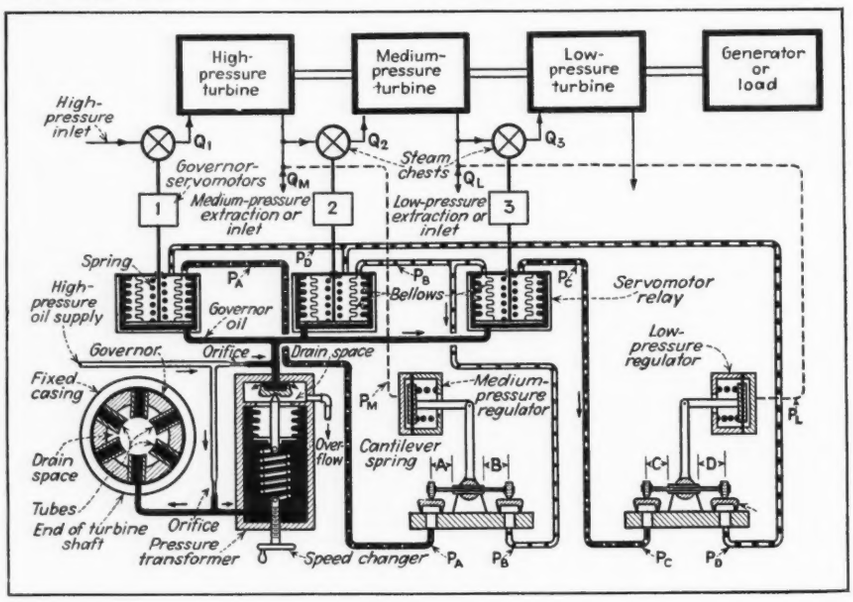
Thus, we can draw the following conclusions as to the conditions the control system must fulfill:

(1) All three governors must alter flows to their respective turbine sections equally for a given change in turbine speed.

(2) All three governors must alter their respective flows equally for a given adjustment of the speed-changer setting when the turbine is operating in parallel with others at a fixed speed.

(3) An increase in high-pressure-steam extraction requires an in-

**Fig. 1—Servomotors 1, 2, and 3 have pilot valves (moved by the servomotor relays) which adjust position of steam-chest valves to suit load or steam variations**



crease in steam flow through the high-pressure element and a decrease in flow through intermediate and low-pressure sections, the amount of which depends on the incremental water rates of the three elements, which in turn are fixed by the steam conditions.

(4) An increase in low-pressure extraction requires an increase in flow through high- and intermediate-pressure sections and a decrease in flow through the low-pressure section, the amount of which depends on the incremental water rates of the three elements, which in turn are fixed by the steam conditions

(5) Pressure regulators for the extraction pressures must have a rather wide range of adjustment to suit the various possible steam conditions and the adjustment should preferably be continuous rather than in fixed steps.

### *Mechanisms Can Vary*

These requirements may be fulfilled by control systems of various types:

(a) Direct-acting mechanically linked valve gear (generally avoided because it has not sufficient power to be sensitive to small variations in pressure).

(b) Servomotor-operated valves having oil pilot valves mechanically linked (more sensitive than mechanical linkage if great care is taken to avoid friction in the pilot-valve linkage. This type also involves quite a problem to fit various sizes and shapes of turbines and to provide for expansion due to temperature changes).

(c) Servomotor-operated valves having oil pilot valves hydraulically interconnected (permitting sensitivity without complexity and allowing any convenient servomotor location without designing mechanical linkage to suit; naturally, oil lines transmit control pressures with negligible friction and a high degree of sensitivity can be obtained).

The hydraulic control system was chosen by Westinghouse Electric & Mfg Co about 15 years ago because it seemed to offer the most flexible means for handling the many special conditions required for industrial turbines. Earlier experience with hydraulic speed governors had shown them reliable and free from wearing parts. They are also easily adaptable to control by other conditions than speed alone.

The hydraulic control shown in Fig. 1, purely diagrammatic and not a true picture as to arrangement and size of parts, has three servomotors with pilot valves moved by the servomotor relays. These relays have spring-loaded bellows or pistons, having three concentric chambers into which three different control pressures are led. The position of the relay depends upon the resultant force of the three pressures and the spring. A change in any one causes a motion of the servomotor to restore balance.

For example, an increase in pressure in the lower chamber of No. 1 relay causes the relay rod to move upward until the increased compression of the spring just balances the increase in pressure. At the same time that the relay rod moves upward, it displaces the pilot valve of the servomotor, which, in turn, causes the servomotor piston to move upward a corresponding amount, thus reducing the flow of high-pressure steam. The ports of the steam-chest valves are designed to give approximately equal increments of steam flow for equal increments of oil pressure.

At the lower left, Fig. 1, is the speed governor, essentially a hollow cylinder mounted directly on the turbine spindles. This cylinder is surrounded by a fixed casing which forms an annular chamber around the shaft. The assembly is sealed by a close-fitting floating sleeve. Oil enters the annular chamber from an orifice supplied from a high-pressure pump. The hollow shaft has several radial holes into which short tubes are fitted. These tubes, of equal length, permit the oil to discharge into the central chamber of the hollow shaft, which connects to a drain space.

When the turbine is at a standstill, the tubes produce no restriction on the flow of oil. However, as the turbine rotates at high speed, the centrifugal force of the oil in the tubes becomes quite large and must be overcome before oil can escape to the drain. At normal running speed the pressure amounts to about 30 lb.

### *Balanced Pressures*

Thus, in effect, each tube, less than two in. long, becomes a standpipe 80-ft high due to centrifugal force of oil in the tube. Since the supply pressure is four or five times governor pressure, there will always be flow through the orifice governor tubes and drain. The pressure in the governor will vary as the square of the rotation speed.

The pressure transformer or amplifier performs two functions: (1) it multiplies the pressure variations of the governor several times and (2) it superimposes the force of the speed-changer spring on the force from the governor oil acting on the bellows. (Thus the resulting oil pressure depends upon both speed and setting of the speed changer). It is then possible to control as many servomotors as desired by means of the one governing-oil pressure.

The pressure transformer consists of

### Typical Simplified Extraction-Turbine Calculation

*Incremental steam rates for three turbine elements are:*
*HP = 50 lb/kw-hr MP = 50 lb/kw-hr LP = 25 lb/kw-hr*
*(neglecting no-load steam flow)*
*Without extraction, 10,000 lb of steam per hr will produce:*

$$\frac{10,000}{50} + \frac{10,000}{50} + \frac{10,000}{25} = 200 + 200 + 400 = 800 \text{ kw}$$

*If 5,000 lb per hr of medium-pressure steam is to be extracted, (10,000-lb-per-hr throttle flow remains constant), power output will be:*

$$\frac{10,000}{50} + \frac{5,000}{50} + \frac{5,000}{25} = 200 + 100 + 200 = 500 \text{ kw}$$

*If 800-kw load is still to be carried, more throttle steam must be admitted. Assume 5,000 lb per hr increase, total 15,000 lb per hr. Then power output would be:*

$$\frac{15,000}{50} + \frac{10,000}{50} + \frac{10,000}{25} = 300 + 200 + 400 = 900 \text{ kw}$$

*which is 100 kw too much. Since 5,000-lb increase raised power output 900 − 500 = 400 kw, and only 300 kw is needed, throttle flow should increase* $\frac{300}{400} \times 5,000 = 3750$ *lb per hr or total 13,750 lb per hr Check load:*

$$\frac{13,750}{50} + \frac{8,750}{50} + \frac{8,750}{25} = 275 + 175 + 350 = 800 \text{ kw}$$

*Total flow to throttle is 13,750 lb per hr plus no-load steam*

a cup-shaped relief valve into which oil is fed from an orifice. It is loaded by three opposing forces: (1) oil pressure on the bellows, (2) force from the speed-changer spring, and (3) oil pressure above the cup valve. The last is always exactly equal to the difference between the first two. Since the bellows area is ordinarily three to five times the area of the cup valve, a 1-lb change in pressure below the bellows will result in a 3- to 5-lb change above the cup valve.

There is a continuous flow of oil through the orifice and hence always a flow through the annular gap between the cup valve and its seat. The cup valve movement is very slight and equilibrium of pressures is reached in a few hundredths of a second.

The operation in case of a decrease in load on the generator is as follows: (1) there is an increase in speed, (2) centrifugal force in the governor tubes increases, (3) pressure below the transformer bellows rises, (4) the cup valve moves upward slightly, (5) pressure above the cup valve rises. (6) Relays of servomotors 1, 2 and 3 all move upward an equal amount, (7) servomotors 1, 2 and 3 all move their valves in a closing direction, (8) steam flows to the three turbine elements are all reduced equally, (9) power developed is reduced until it equals the new load, (10) acceleration ceases and all valves remain stationary until load changes again.

The extraction-pressure regulators, connected at the extraction points, are identical in principle although the low-pressure diaphragm is made much larger than the one for medium pressure so its sensitivity will be equal to that of the latter. Diaphragms are loaded by springs or weights in opposition to the steam pressure. A lever connects the diaphragm to a shaft to which is clamped a double cantilever spring. Each end of the spring loads a cup valve to produce a control pressure.

These cup valves are supplied with oil from the high-pressure oil pump through orifices (not shown in the diagram). The action of these valves is exactly like that of the valve in the transformer. The pressures $P_a$, $P_b$, $P_c$, and $P_d$ are directly proportional to the spring loads on each cup relief valve. As $P_m$ increases, the lever moves to increase $P_b$ and decrease $P_a$ an amount depending on the stiffness of the cantilever spring. The spring is clamped at the center so that it can be slid laterally to give the correct ratio between the pressure changes and consequently the steam flows.

### *For Less Extraction*

A decrease in demand for medium-pressure steam, for example, causes the following: (1) pressure at medium-pressure extraction point begins to rise, (2) medium-pressure regulator moves clockwise, (3) oil pressure $P_a$ decreases so that relay moves upward and reduces steam flow.

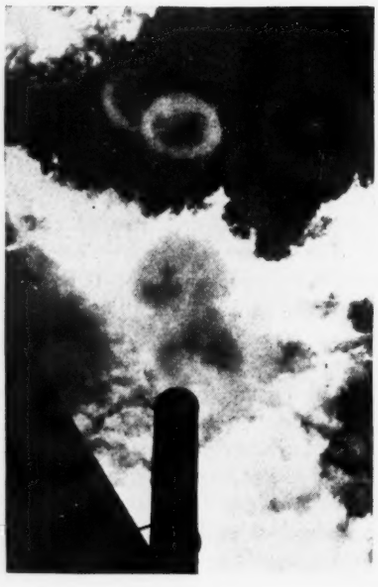
(4) Oil pressure $P_b$ increases, causing a greater downward force on No. 2 and No. 3 relays, thus raising steam flow to medium- and low-pressure sections of the turbine. (5) If spring lengths A and B are correct, the decrease in power developed in the high-pressure turbine element will just equal the increase in the medium- and low-pressure elements. (6) When $P_m$ stops rising, equilibrium has been reached at the new extraction flow.

The same sequence of operations occurs when a decrease in demand for low-pressure extraction steam is experienced, and opposite sequences when steam demands increase. From this, it is also evident that steam can be inducted at either or both extraction points, that is, excess medium- and low-pressure steam can be utilized in an extraction turbine. The regulators automatically cause the turbine to use as much inducted steam as possible and as little high-pressure steam as required to make up the full power requirements. When there is so much steam available at the extraction points that all high-pressure steam is cut off and the inlet pressure still rises, the regulators eventually reach their limit stops.

All three servomotors are always under control of the governor and the regulators act merely as devices for shifting load from one part of the turbine to another to suit extraction demand. Consequently, there is a definite limit to the amount of steam that can be extracted or inducted at any given power load.

Mechanically interconnected pilot valves can be made to perform the same functions as the hydraulic system. The operating requirements to be fulfilled are the same in either case. This article describes the hydraulic system only in an effort to create a clearer understanding of the principles underlying extraction-turbine control.

# Exhaust Lines



By L N ROWLEY

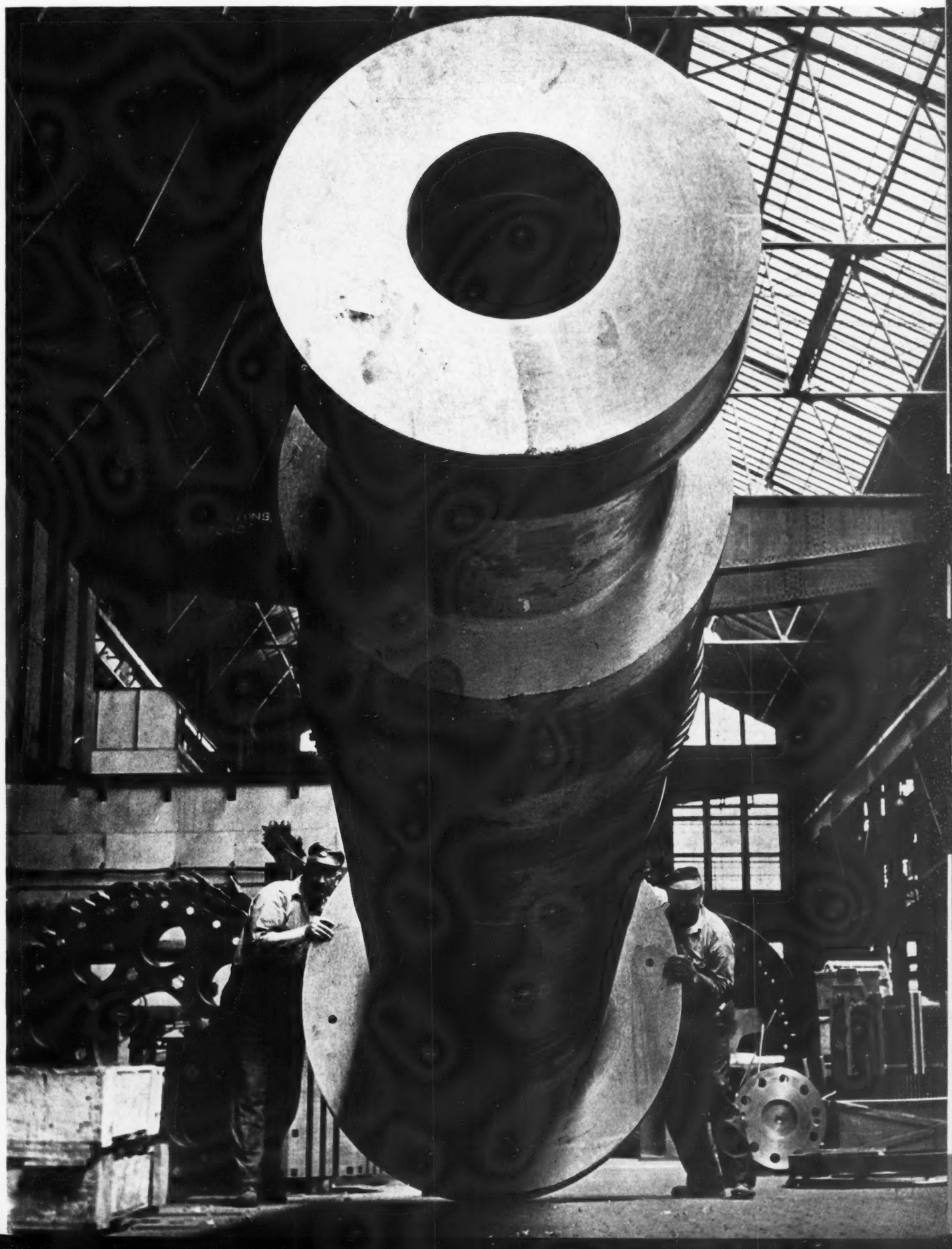
F T Moon, Chief Engr of the Kinnett Odom Ice Co, Macon, Ga., can claim credit for efficient operation of a gas-engine-driven ice plant, but all the good operation in the world can't teach engines to blow smoke rings from the exhaust pipe—that's got to be born into the setup by some freak combination of circumstances. Regardless of what causes this display of skill, the rings are quite a sight—well formed, and regular as clockwork. Just to prove it isn't all a gag, I brought back the evidence. Take a look at the picture and then "believe it or not"!

*The "Sinclair Firebox" tells one about a new but brash fuel-oil salesman. The prospect complained, "I don't think I get good combustion with this fuel—the flame looks cold and I don't believe the $CO_2$ is high enough. Are you sure I'll get higher $CO_2$ with your oil?" "My dear sir," came the immediate reply, "with our oil you won't get any $CO_2$ at all—you'll get $CO_3$!"*

In Carrollton, Ga., E P Vaughan, Supt of the Lawler Hosiery Mills, showed me a plant-built superheater "fired" by the exhaust from a new Bruce-MacBeth gas engine. Steam on its way from the boiler to the boarding room passes through an insulated manifold around the exhaust line; the temperature boost helps stockings dry faster. Engine jacket heat does day and night duty; during the day, it raises feedwater temperature; at night, when the boiler shuts down, the jacket heat builds up a supply of hot water for the dyehouse so no time is lost in starting up in the morning.

# Gun of Industrial Defense

130,000-lb shaft for 75,000-hp Bonneville hydroelectric generator abuilding at General Electric Shops, Schenectady, N. Y.



Late Model
Curtiss-Wright Plane

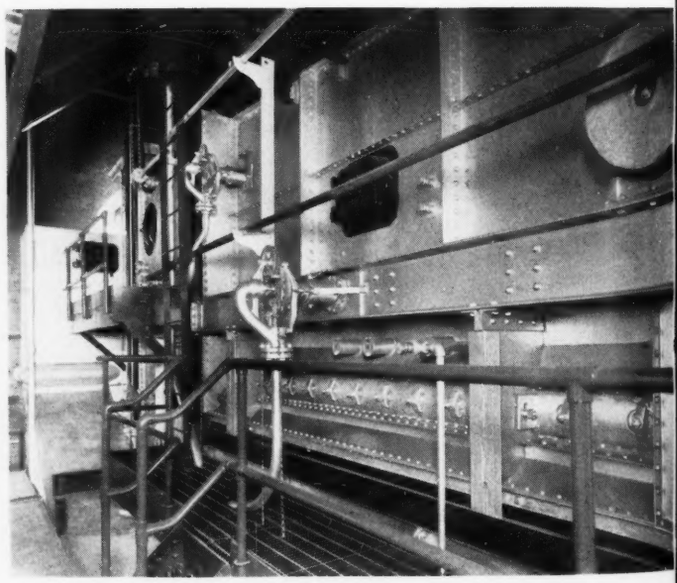
# RILEY BOILER UNIT REDUCES STEAM C

The Curtiss-Wright boiler plant at Buffalo, N. Y., consisted of three 400 H. P. straight tube boilers fired by traveling grate stokers with space allowed for an additional unit. Rapid expansion of the aeroplane industry in recent years increased steam demand beyond the capacity of the existing plant.

A thorough investigation indicated the advisability of installing a modern high efficiency unit rather than merely installing a duplicate of the existing units.

A Riley Boiler Unit fired by Riley Pulverizers and Burners was ordered October 11, 1939. The unit went on the line February 1, 1940, and has been carrying the plant load since that time with complete satisfaction. Efficiencies of 86.2% are being obtained. Results indicate fuel savings in excess of $10,000 per year. Another well-known company has become a Riley booster.

Engineers are invariably impressed with the ease with which new Riley Boiler Units are placed on the line and by the absence of even starting up difficulties. Efficiencies and capacities in excess of guarantees is the general rule with Riley Units. User enthusiasm is definite evidence that Riley gives you your money's worth.



View of casing seals at upper water wall header. Attention to detail of casing construction assures air tightness.

TRADE MARK Rx REGISTERED

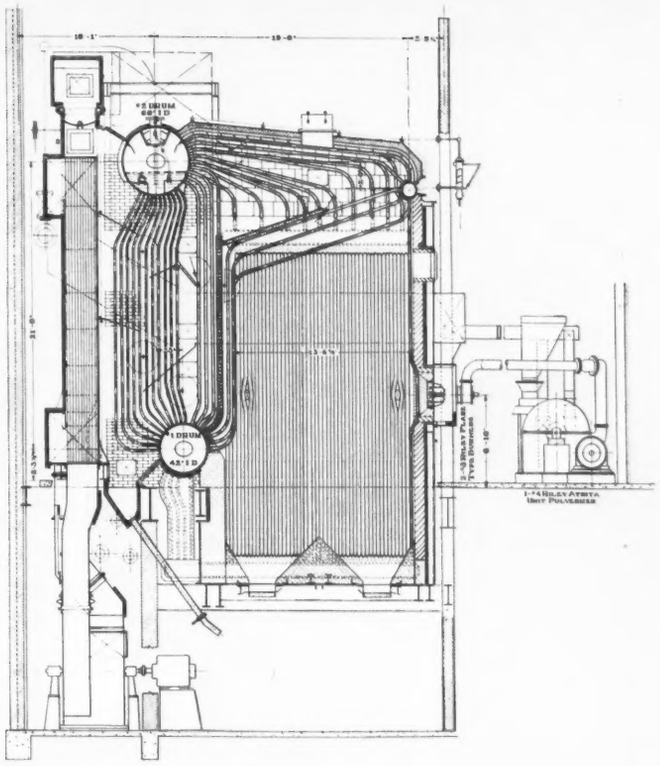
# RILEY

**STOKER CORPORATION, WORCESTER, MASS.**

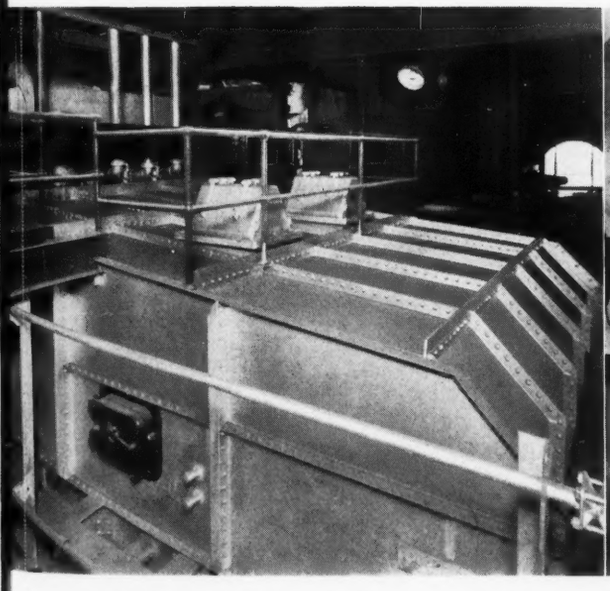
Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore Milwaukee Denver
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

**It will pay you to visit modern Riley Installations**

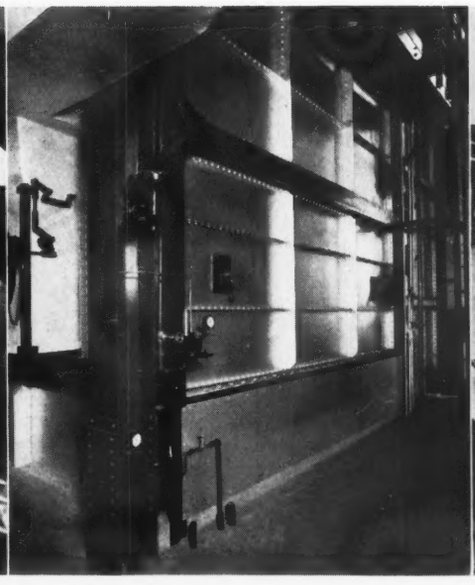
Riley Boiler Unit of Curtiss-Wright Aeroplane Corp., Buffalo, N. Y.
70,000 lbs. of steam per hour.
86.2% efficiency at 50,000 lbs./hr.
Unit consists of Riley Boiler, Water-cooled Furnace, Steel-Clad Insulated Setting, Air Heater, Riley Pulverizer and Burners.



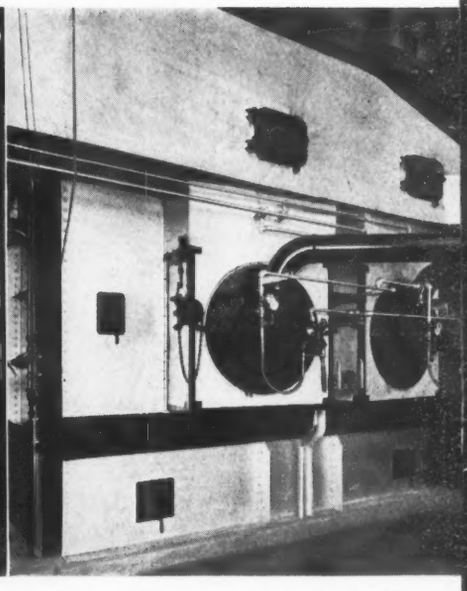
# COST FOR CURTISS-WRIGHT



Casing construction over boiler roof. The cost of a flanged casing rather than batten strips is greater but positive tightness is assured.



View of side of unit. $CO_2$ reduction between furnace and air heater outlet with Riley units is less than ½ of 1%. Evidence of the worth of the Riley flanged casing construction.



Front of Riley unit at Curtiss-Wright. Combination oil and pulverized coal Riley burners are used.

*A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs*

## COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

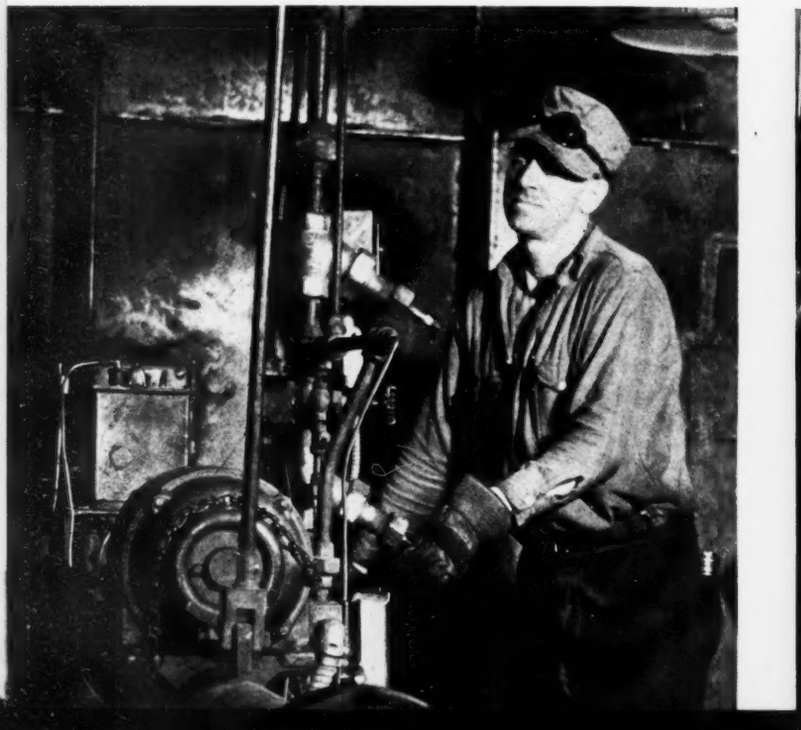
**before purchasing Boiler or Fuel Burning Equipment**

# From Coal to Kw at Springdale

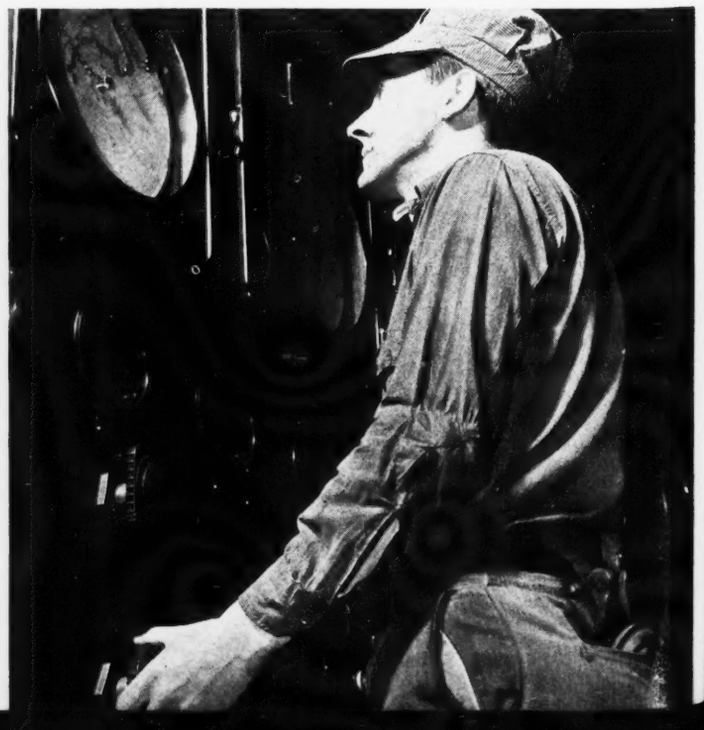
*Largest of West Penn Power Co's generating stations is 210,000-kw Springdale, serving a large area in western Pennsylvania, excluding Pittsburgh and Allegheny County. Steam from three boilers at 1250 lb, 930 F, goes to the new No. 6 topping turbine, then at 340 lb to five low-pressure machines also served by 8 other boilers. Photos on these two pages, taken by West Penn, show men and machines on the job*

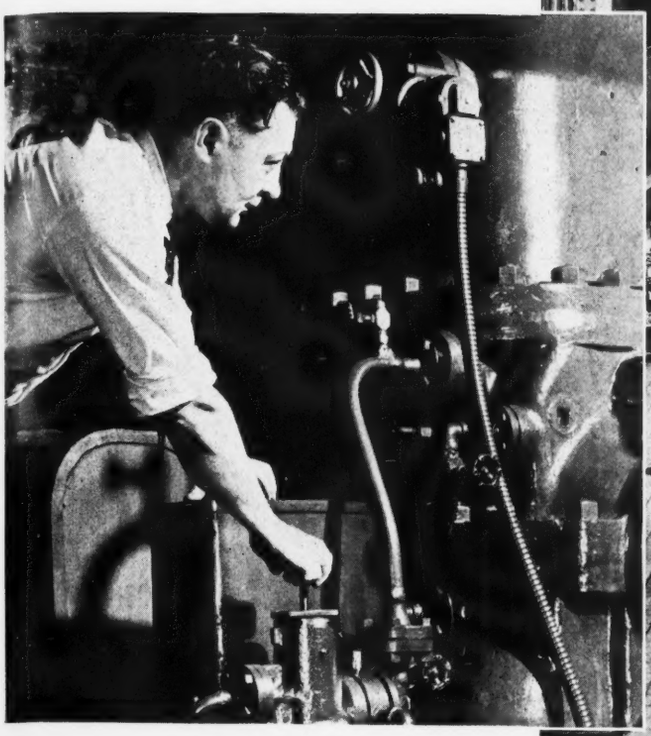
Edgar Allen takes a sample of pulverized coal on its way to the burners

G W Crawford operates telescopic soot blower which cleans boiler tubes with live-steam spray



Boiler operator Howard Drummond keeps an eagle eye on steam flow to turbine units



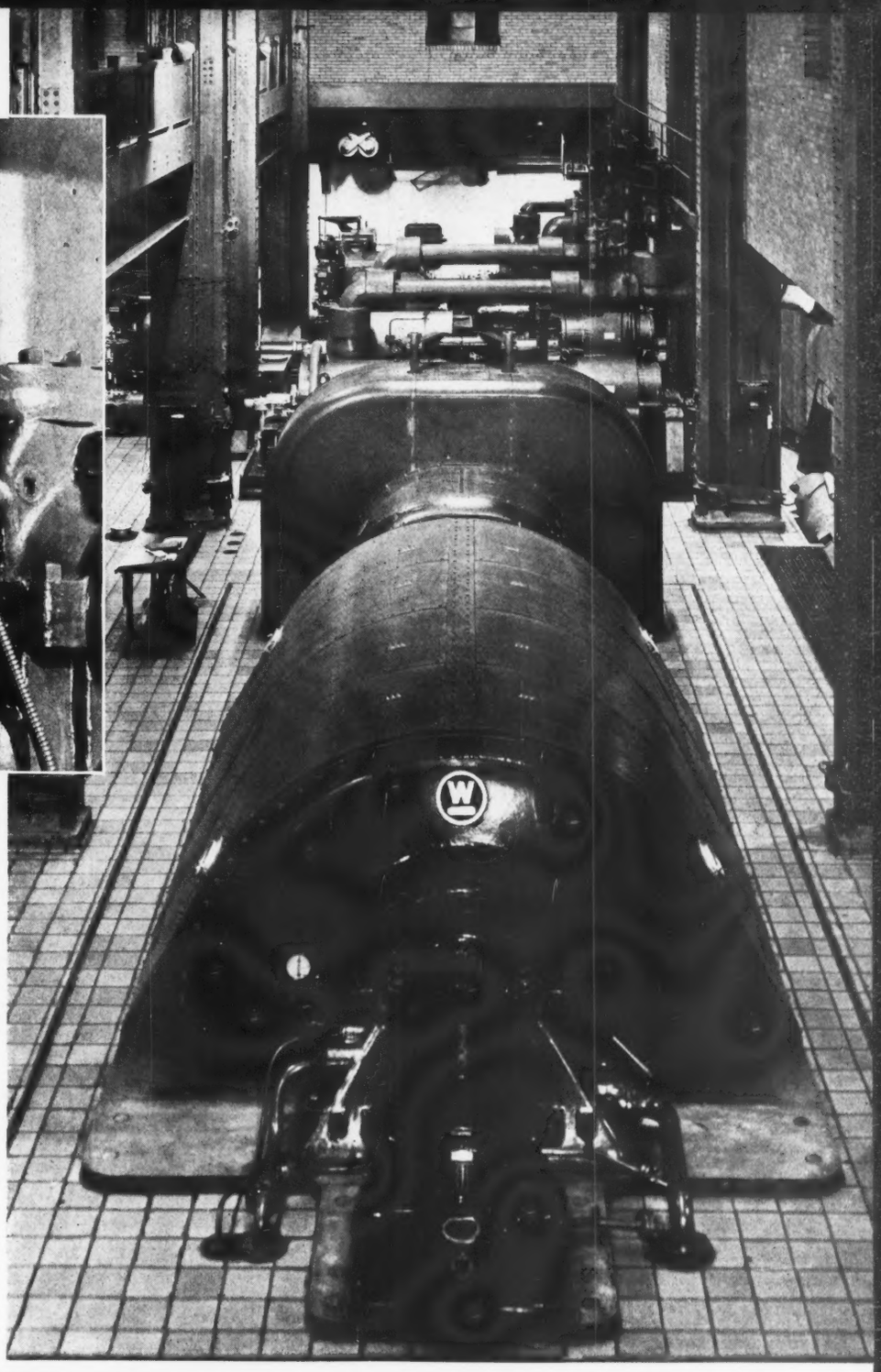


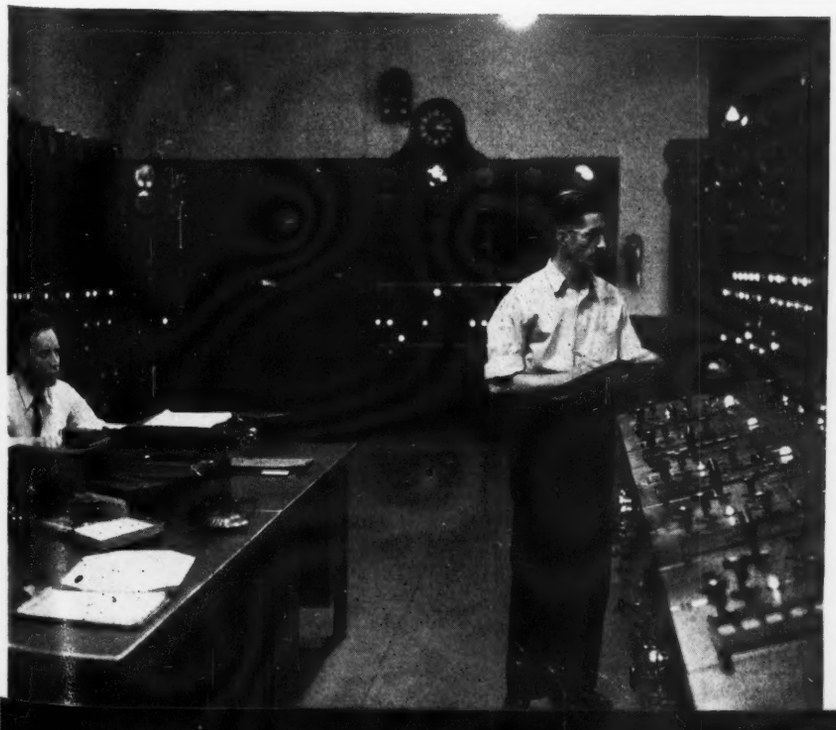
Above—Chief engineer Bill Eisler sets the load-limiting device on No. 6-turbine governor

Right—Springdale's year-old topping turbine, using steam at 1250 lb, 930 F, turns out 50,000 kw

Lower left—At the nerve center of the station, operators P C (Red) Miller and L G Kunkle keep track of outgoing kilowatts

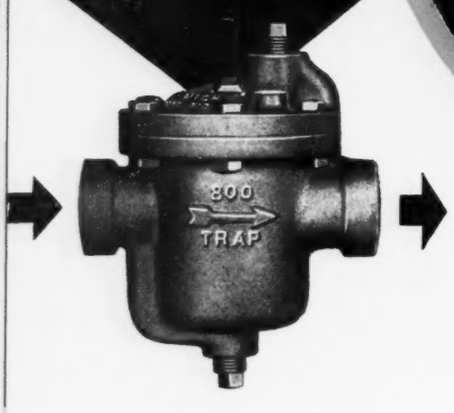
Lower right—No plant can get along without maintenance. Here maintenance man Art Gornall (left) and assistant master mechanic Bob Seaton get set to repair worn spindle gland





# Now! Better for

# 2 New Traps



## QUICK FACTS:

THE new No. 800 and 801 traps shown here are new editions of the famous "fist size" Armstrong No. 200, 201, 202, and 203 traps. Following is a brief summary of principal features:

**1.** ONE-PIECE ALL-STAINLESS STEEL BUCKET. Cold drawn from sheets. Bucket strap is welded to top of bucket.

**2.** STRAIGHT-THRU PIPE CONNECTIONS with No. 800. No. 801 is dimensioned for standard angle connections.

**3.** TOP QUALITY. Interior mechanism is same as used in Armstrong traps for 1500 lbs. pressure.

**4.** NEW PART ADDED. Easy location of gasket is provided by addition of a metal thimble at joint between cap and body in discharge passage.

**5.** MORE RUGGED. 12½% more metal added at connection points around water passages, etc. Redesigned cross-section for water passages make for freer flow.

Carried in stock at 135 points in United States and Canada. ARMSTRONG MACHINE WORKS, 812 Maple St., Three Rivers, Mich.

## MATERIALS USED:

| Part No. | Name | Material |
|---|---|---|
| 1 & 2 | Cap and Body | Cast Semi-Steel, 33,000 lbs. tensile strength |
| 3 | *Seat | Chrome Steel |
| 4 | Guide Plate | Stainless Steel 18-8 |
| 5 | *Valve | Chrome Steel |
| 6 | Lever | Stainless Steel 18-8 |
| 7 | Bucket | Stainless Steel |
| 8 | Retainer | Stainless Steel 18-8 |
| 9 | Gasket | Compressed Asbestos, 1/32" |
| 10 | Bolts and Nuts | Steel, 90,000 lbs. minimum tensile |
| 11 | Thermic Vent | Stainless Bi-metal and Stainless Steel |
| 12 | Test and Drain Steel | Steel |
| 13 | Thimble | |

*Valve and Seat are heat treated after machining.

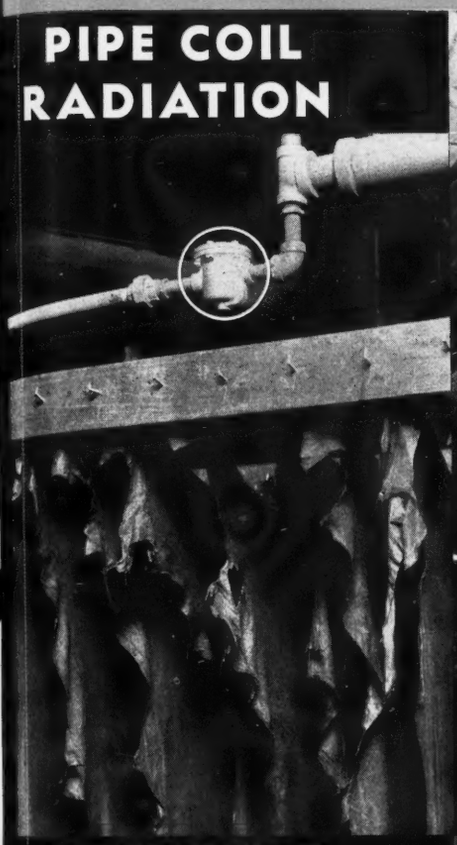
## DATA AND LIST PRICES

| Trap Size | | No. 800 | No. 801 |
|---|---|---|---|
| Pipe Connections | | ½" or ¾" | ½" or ¾" |
| List Price (Regular) | | $7.00 | $7.00 |
| List Price (Blast Trap) | | $8.50 | $8.50 |
| Telegraph Code (Regular) | | Aloe | Arrow |
| Telegraph Code (Blast Trap) | | Aloette | Arrowette |
| Diameter | | 3¾" | 3¾" |
| Height | | 5⅛" | 6" |
| Number of Bolts | | 6 | 6 |
| Diameter of Bolts | | ¼" | ¼" |
| Weight | | 4½ lbs. | 4½ lbs. |
| Maximum Pressure, lbs. | | 125 | 125 |
| Continuous discharge capacity in lbs. of water per hour at pressure indicated. | 5 Lbs. Pressure | 450 | 450 |
| | 10 | 560 | 560 |
| | 15 | 640 | 640 |
| | 20 | 690 | 690 |
| | 25 | 460 | 460 |
| | 30 | 500 | 500 |
| | 40 | 550 | 550 |
| | 50 | 580 | 580 |
| | 60 | 635 | 635 |
| | 70 | 660 | 660 |
| | 80 | 690 | 690 |
| | 90 | 620 | 620 |
| | 100 | 640 | 640 |
| | 125 | 680 | 680 |

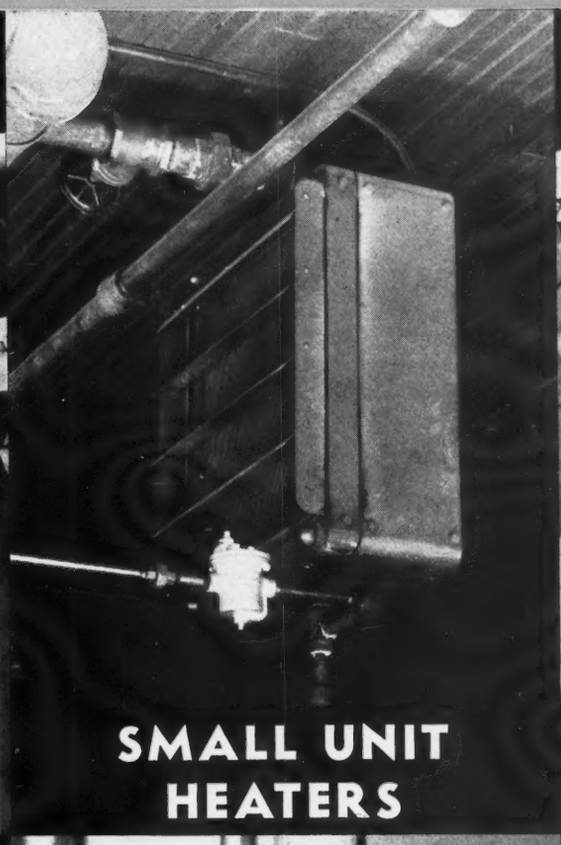
ARMSTRONG "INVERTED BUCKET" STEAM TRAP

# ARMSTRONG

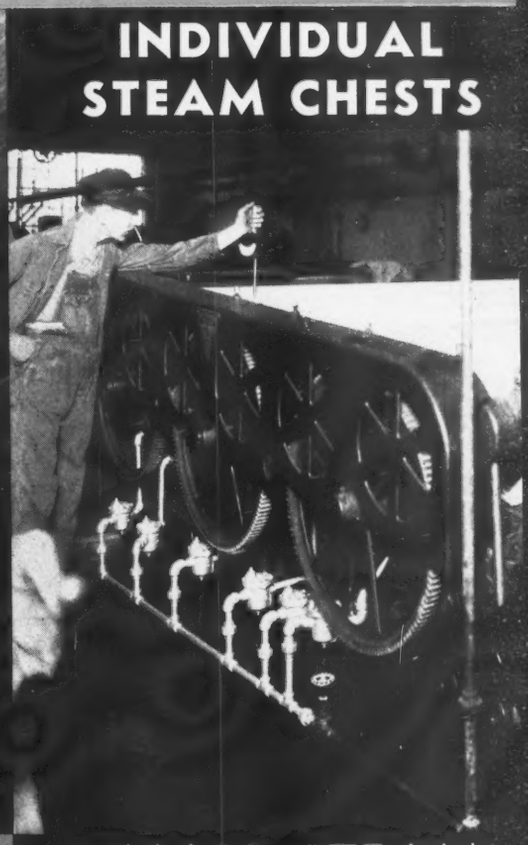
# Trapping



PIPE COIL RADIATION

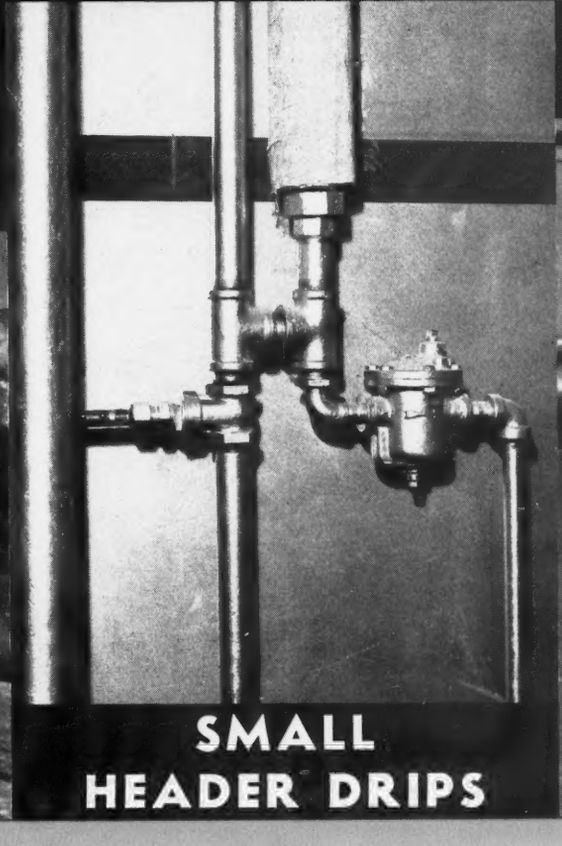


SMALL UNIT HEATERS

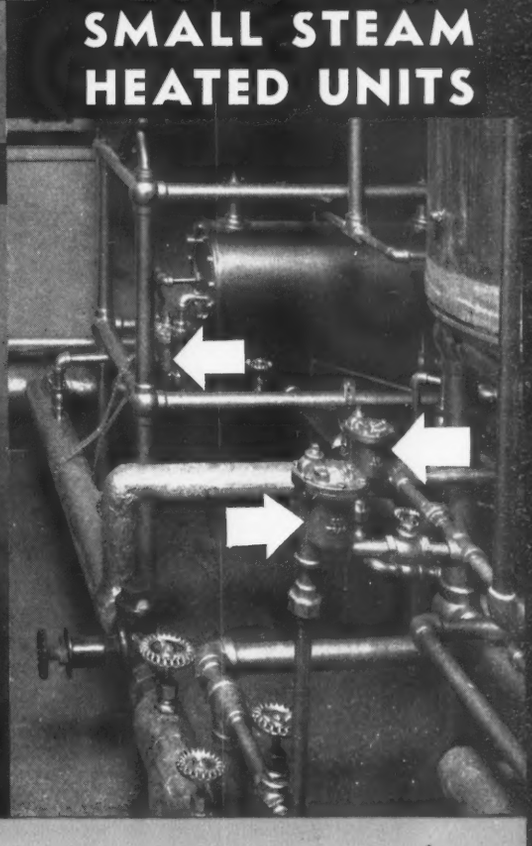


INDIVIDUAL STEAM CHESTS

MOULDING PRESSES



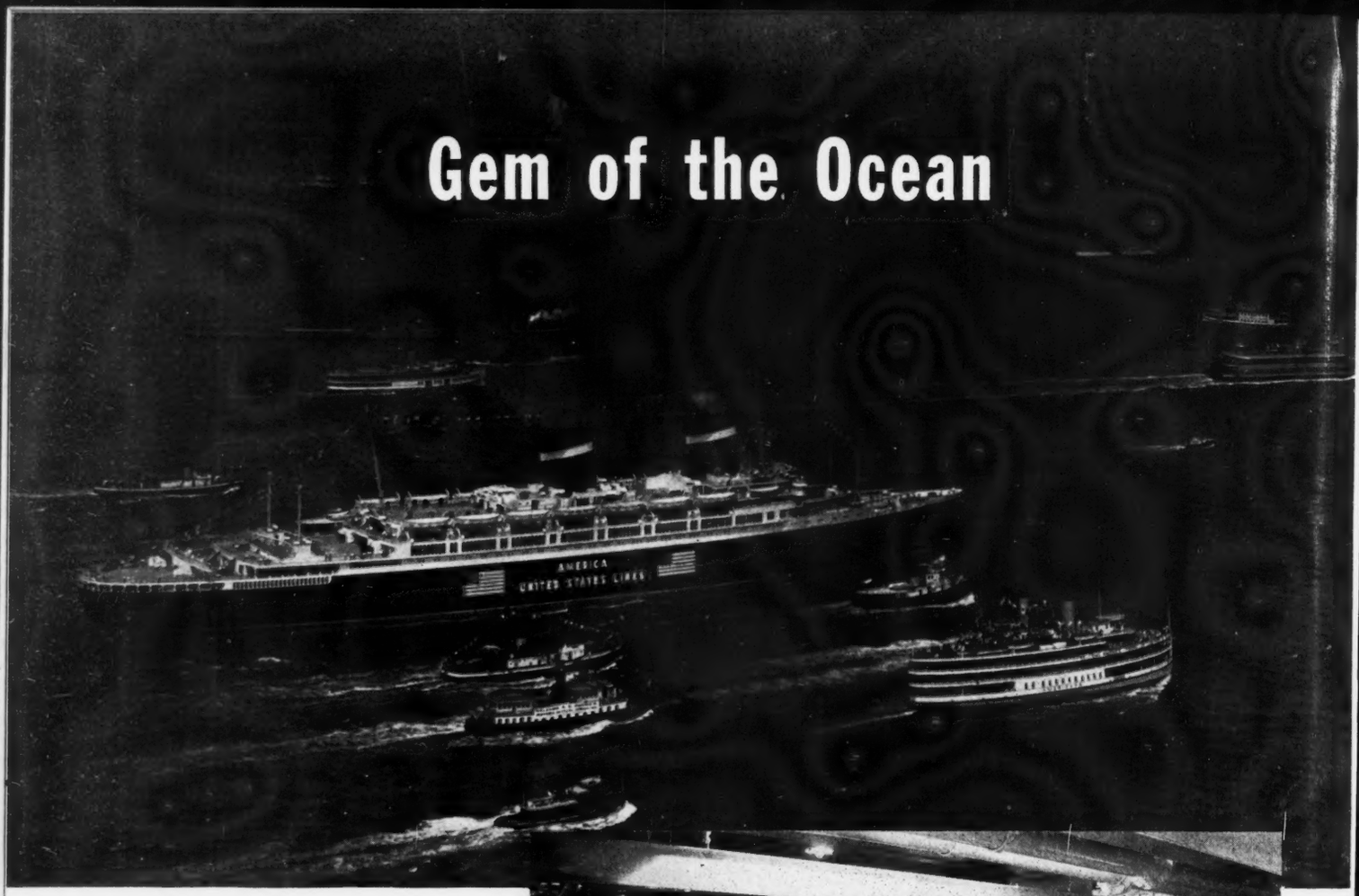
SMALL HEADER DRIPS



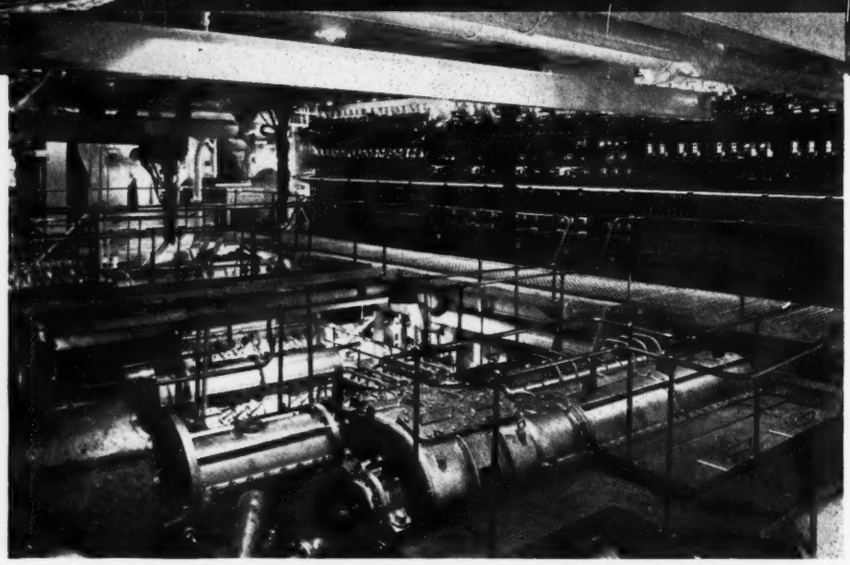
SMALL STEAM HEATED UNITS

# STEAM TRAPS

# Gem of the Ocean

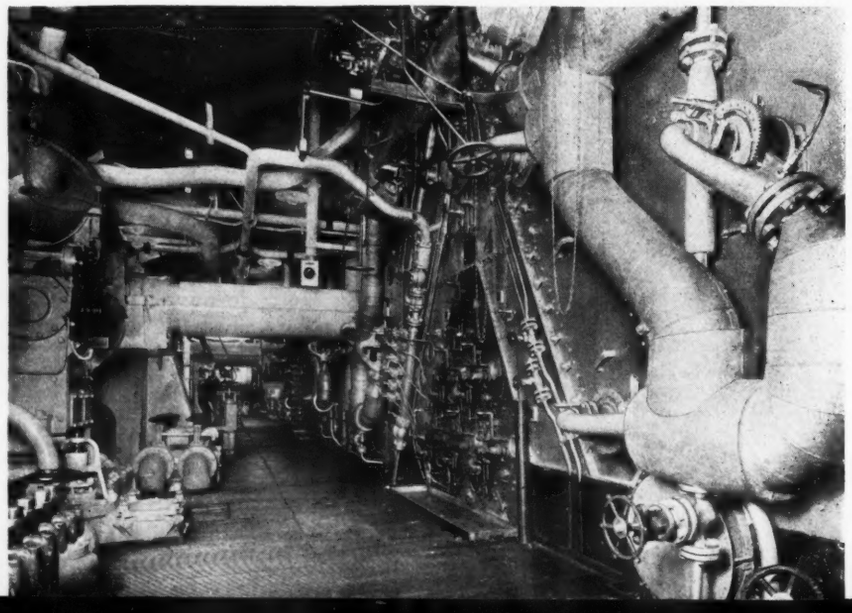



The "America" in N. Y. Harbor on her maiden voyage, July 29



Main propulsion machinery consists of two triple-expansion turbine sets, taking steam at 425 lb, 725 F. Service requirements are met by four 600-kw turbine-generators

One of the two boiler-rooms—each has three 315,000-lb-per-hr steam-generating units



▶ Largest merchant ship ever built in this country is the U. S. Lines' *America*, 723 ft long, 35,440 tons displacement, 37,400 max shaft hp. Compared to the *Normandie's* 1029.5-ft length and 160,000 shaft hp, or the *Queen Mary's* 1018 ft and 200,000 shaft hp, the *America* doesn't cut much ice, but the *Normandie* is tied up in N. Y. harbor—a ship without a country—and the *Queen Mary* is "somewhere" ferrying British troops. The only one you can buy a ride on is the *America*.

The power plant of this twin-screw vessel contains six B&W oil-fired marine boilers, supplying steam at 425 lb, 725 F, to two triple-expansion turbine sets. Each turbine set consists of a high-pressure unit driving through double reduction gears, and intermediate- and low-pressure units direct coupled to pinions engaging the main gears.

Power-service requirements on a ship of this size are tremendous. There are over 150 motors and more than 100 pumps, several elevators, and compressors for air-conditioning. These needs are supplied from four 600-kw turbine-generators.

# A G Spalding Puts the Squeeze Play on Steam-Generating Costs

***Manufacturer of baseballs and bats and other athletic equipment saves $40,000 per year by modernization and installation of automatic control***

*As told to* C C HERMAN by
V T FAHRINGER, *Chief Engineer*

▶ WHEN WE THINK of golf, tennis or baseball, we think of A G Spalding & Bros, Inc, where potential home runs are turned out by the carload and tennis balls by the tens of thousands. The parent plant at Chicopee, Mass., makes tennis racquets, ball bats and other items. Two miles away, Plant No. 2, at Willimansett, manufactures tennis balls, baseballs and all rubber goods.

### *Power Needs*

Both plants require large amounts of steam during the heating season and smaller amounts during the summer for process. Because all power needs are supplied by a hydroelectric unit supplemented by utility service, steam requirements are low pressure—15 lb saturated.

At Chicopee, a 2500-sq-ft Union Iron Works boiler fired by Petroleum Heat & Power Co oil burners generates steam for process needs (Fig. 1); Plant No. 2 contains two 2500-sq-ft Fitchburg boilers equipped with Petroleum Heat burners, Fig. 2.

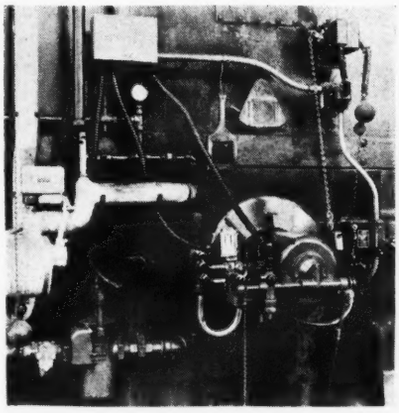


**Fig. 1—A 2500-sq-ft, oil-fired boiler with fully automatic control eliminated attendant cost at Plant No. 1**

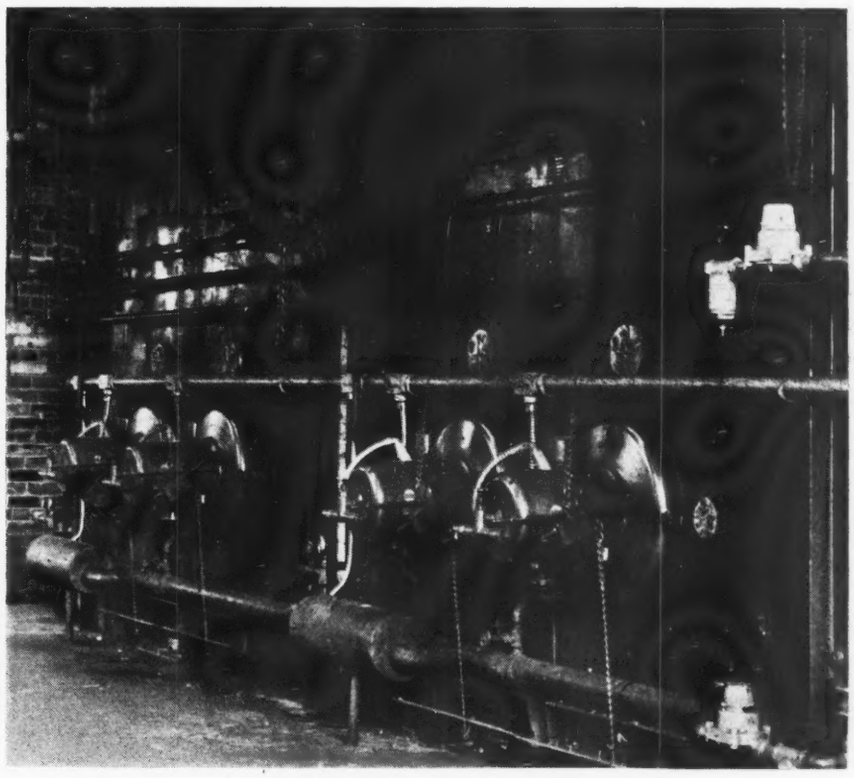


**Fig. 2—These two boilers take care of steam requirements at Plant No. 2**

Until 1938, both plants burned bituminous coal costing then $6.55 per ton delivered at the plant. To operate these three steam units continuously required 10 men. That year, Plant No 1 was changed to oil at a cost of $6000, which included necessary oil-storage tanks, oil-heating mains, pumps and burners. This worked out so nicely that Plant No. 2 was changed over also.

Boiler operation at Plant No. 1 is now entirely automatic. The oil supply line is piped across the burner head and provided with a pressure-relief valve; the oil-circulating pump operates continuously so that heated oil flows past the burner at all times. The heater is shown at the left of the burner, Fig. 1, and consists of an electric element in a reservoir as near as possible to the burner. Oil temperature is maintained at 170 F.

Last year, steam cost dropped to $0.35 per 1000 lb of steam, which meant an annual saving of $40,000. Instead of having ten men working all the time at the steam plants, one to one and a half hours of one man's time are now charged on weekdays and about one-fourth of one man's time on Sundays and holidays.

# Longer Life for Diesel Lube Oils

***Even the best lubricating oils must be treated with respect; by knowing how to keep down contamination and how to purify and reclaim, operators get the most out of their dollar. Last of a series on diesel operation by S S Hansen, Chief Lubricating Engineer, General Petroleum Corp***

▶ CHOOSING THE RIGHT lubricating oil represents only a start—a good start, but no more. Even the finest lubricating oil must be treated with respect; the operator must know what changes may take place in the oil structure during service, what impurities may find their way into the oiling system, and, finally, what to do to get maximum life from the lubricant so carefully chosen.

### *Impurities*

Used oils from diesel engines differ from new oils in that they contain certain products of decomposition and impurities:

1. Products of oxidation, cracking and polymerization of hydrocarbons due to the combined action of air and heat. These products are frequently referred to as oxidized oil, gum, sludge, organic acids, asphaltenes and carbon (when the decomposition has progressed to the point of formation of materials insoluble in the most efficient organic solvents). These products may come not only from the lubricating oil but also from the fuel oil.
2. Fuel-oil dilution caused by incomplete combustion and blowby.
3. Water condensed from air or combustion gas.
4. Mechanical impurities such as dust passing the air filter, metal particles from engine wear (particularly iron and bearing metals, and rust).
5. Small amounts of soaps resulting from reaction of acidic products of oxidation of hydrocarbons and metals.

In all practical cases, part of the impurities and products of decomposition of oil and fuel appear in the crankcase oil, and part form the deposits in the engine. The design, mechanical condition and type of operation control the distribution of impurities and the rate of engine fouling to a greater extent than the lubricating-oil characteristics. It is, therefore, impossible to separate the lubricating service from other phases of operation, and the lubricating engineer in his analysis of used oil has to consider all angles of the case.

There is no general answer to the question of usability of lubricating oil after it has been drained from the crankcase or circulating system. Each case forms an individual problem, involving the consideration of the design and condition of the engine, grade of fuel and lubricant, rate of deterioration of oil, etc. However, a laboratory test will reveal many points regarding the nature and amounts of impurities present and a study of the analysis will give not only an approximate answer to the question of re-use, but also many hints as to ways and means of improving combustion processes, condition of the cooling system, efficiency of air and crankcase filters, and other important factors.

Because everything that goes on inside a diesel leaves some trace in the lubricating oil, the operator who wants to keep his lubricating cost down will do well to ask the company from which he buys lubricants to make periodic analyses of his used oil. The competent oil chemist can build up an enlightening picture of a particular engine's operation from the clues appearing in its lubricating oil after a period of service. Using the recommendations resulting from such an analysis as a guide, the operator can tell whether to change the oil or reclaim it and what to do to get longer service life, better engine performance, or both.

Assuming that he has selected the correct oil for his engine, the operator can insure long and efficient service by proper care of the oil and regular attention to the cleanliness of the oiling system. Impurities cause the objectionable conditions that may arise in a circulating-oil system and tend to hinder efficient operation and lessen the life of the oil. The nature of these impurities depends, to some extent, on the construction of the engine.

In single-acting engines, where the power cylinders are open to the crankcase, incompletely burned fuel, carbon particles, and other impurities mix with the cylinder-lubricating oil, work past the pistons and drain to the crankcase. It is not the mere presence of impurities that does harm, but their presence in excessive quantities or their accumulation over a period of time.

Contamination of lubricating oil with liquid fuel, known as "dilution," occurs to a lesser extent in diesels than in other types of internal-combustion engines. But when diesels operate in dusty surroundings, other impurities may enter with the intake air; foreign particles find their way to the bearings, and mineral dust, if any is present, may cause considerable wear. Excessive contamination robs lubricating oil of its ability to protect engine parts properly.

### *Emulsification*

Foreign impurities in lubricating oil predispose the oil to emulsification if water is present. If the water has accumulated to an appreciable extent, any rapid circulation with these emulsifiers (carbon, iron oxide, sand, and dust) will frequently produce a persistent emulsion, from which the water will not readily free itself. Such emulsions may deposit on cooling coils and insulate them; they may restrict oil flow to the bearings; in severe cases they may even result in failure of lubricating-oil films.

In double-acting diesels and single-acting engines where power cylinders have no communication with the crankcase, there is less chance for contamination by fuel, water, and other impurities. In service, however, the lubricating oil, which is a complex mixture of hydrocarbons, will often develop impurities by oxidation. Heat accelerates this action and so does subdivision of the oil into a fine spray or mist—a condition brought about by service in a circulation system.

Oxidized hydrocarbons may be divided into two classes—those soluble in

oil and those insoluble. Hot oil will hold in solution a greater amount of soluble oxidized hydrocarbons than will cold oil. These hydrocarbons do not deposit at normal working temperatures, but precipitate on the cold surface of cooling coils, interfering with heat transfer, and in other parts of the oiling system where the oil is quiet and there is a sufficient temperature drop.

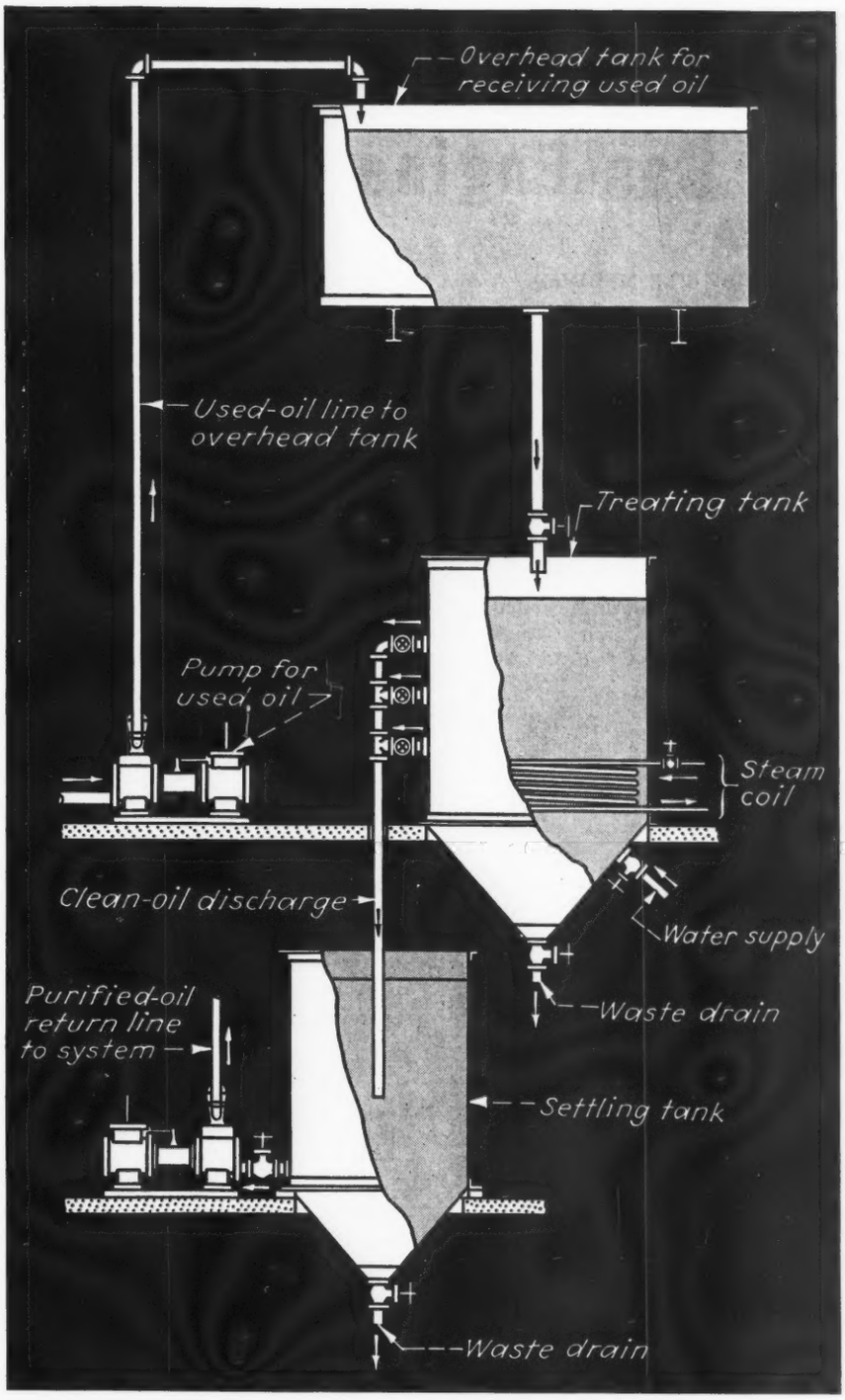
Insoluble oxidized hydrocarbons may be carried in circulation, tending to deposit on strainers, oil pipes, oil passages, and particularly in reservoirs. These deposits may interfere with oil cooling; they may clog the system and in severe cases stop the flow of oil to the bearings. Moreover, oxidized hydrocarbons, whether soluble or insoluble, impair the resistance of oil to emulsification and aid in the eventual formation of sludge.

### *Neutralization Number*

The best of today's diesel oils consist of stable hydrocarbons that resist oxidation. This does not necessarily mean that the neutralization number will not show slight and gradual increases during extended service. Where such increases occur, however, they are due to the natural service of the oil. They should not be taken as absolute indications of any possibility of breakdown, nor of the need for removal and batching, providing the oil in question is one of known service value.

Neutralization number taken by itself does not determine the condition of oil. When an analysis of used diesel oil is made, the chemist takes other readings; color, viscosity, P E and chloroform, and insolubles, for comparison with previous readings on used oil. Only by studying all these items in their relationship to each other can condition of the oil with respect to its ability to continue service be determined.

The rate at which contaminating impurities accumulate in a circulation oiling system depends on many contributing factors: (1) nature of the engine service, (2) mechanical condition of the engine [particularly of the pistons and rings], the tightness of the joints between liners and water jackets and of piston water connections, (3) care in operation, in minimizing incomplete combustion by assuring efficient atomization so that fuel is not left in the cylinders in liquid or carbon form, (4) engine load and working temperature, (5) proper control of cooling water, (6) purity of the fuel, (7) correctness and quality of the oil, (8) rate of oil circulation, (9) frequency of starting, and, (10) effectiveness of purification.




**A simple purification system for diesel lubricating oil**

In a circulation system, agitation in the pump and passage through pipes and ducts promotes an intimate mixture of impurities and lubricating oil. When the operator shuts down the engine, the idle period affords opportunity for impurities to settle. Of these, free water settles without great difficulty and collects at the bottom of the crankcase or sump. As the temperature drops, soluble impurities precipitate. Suspended foreign matter and sludge may settle extremely slowly and may be light enough to remain in suspension. As soon as the engine starts again, the settled impurities will be drawn into circulation once more and some of them will dissolve in the warm lubricating oil.

Purification of diesel-lubricating oil should aim at removing sludge and suspended impurities and at restoring the oil to its original condition. The purified oil will be darker than the original oil, the darker color merely indicating the presence of harmless colloidal carbon and not poor condition or inferior oil.

Most plants employ one of three main systems for purification: (1) the oil is

*(Continued on page 138)*

# Does Condensation Cause Gas-Engine Wear?

By BILL MADDOCK, *Tucson Gas, Electric Light & Power Co*

▶ To a growing extent, lubrication experts tend to blame cylinder-wall condensation for excessive cylinder wear in internal-combustion engines. Evidence that increasing jacket-water temperature reduces the rate of wear in many cases seems to bear this out.

To some it may seem absurd to talk of condensation in an internal-combustion engine. However, combustion-data tables (Power, Oct. 1939) show, for example, that each lb of gasoline burned produces over one lb of water, and that a 50-hp natural-gas engine (using 10 cu ft of gas per bhp hr) can form 50 lb of water per hr of operation.

If water *alone* caused excessive wear, it would mean that condensation occurred in sufficient quantities to either wash the oil from the wall, or water adhered to the wall so the oil could not do so. If this were true, we would expect to find the greatest wear on the lower part of the stroke, before exhaust, where the combination of relatively high pressure, slow flame travel, and cold cylinder walls exists.

On the contrary, the heaviest wear, attributed to condensation, appears at or near the top of the stroke. If the temperature at this point runs too high to let condensation take place at the time of combustion (during the power stroke), and if no excessive wear occurs at the bottom, it seems highly probable that the wear doesn't occur on the power stroke at all. This places the wear as happening during the compression stroke.

Remember that the unscavenged gas is saturated and that there may be some condensation on the lower part of the cylinder. All during the compression stroke there occurs a constant liberation of heat and the farther up the stroke the more the possible moisture. Additional water may be brought in for compression by "over-washed" scavenging air. Fig. 1 shows the condensation curve for wet scavenging air alone, without considering the moisture left at the end of the power stroke.

Water, however formed, can dissolve large amounts of carbon dioxide to form carbonic acid. Given heat and time, this weak acid will corrode iron cylinder walls. Of a more serious nature is the solution of sulphur dioxide, which forms sulfurous acid. This action is much stronger and has been long regarded as a contributor to bearing failure.

Fig. 2 shows the temperature and pressure of condensation for exhaust gases having different amounts of water due to combustion. Note that the temperature line for the expansion runs higher than 180 F for a large part of the time. This means that at any point or time during the expansion when the jacket-heat-transfer is more rapid than the flame front, condensation may result. In a slow-burning diesel the flame front is supposedly continuous, but in the Otto cycle, the drops of water could form shortly after the explosion. Since Otto-cycle gas engines experience some of the most serious wear, the evidence tends to support the theory that high-hydrogen fuels do accelerate cylinder wear.

### *How Much Water?*

The amount of water formed is usually calculated on the assumption that all of the hydrogen will unite with the oxygen supply, regardless of whether there is enough to satisfy the carbon or not. For example, if $CH_4$ is burned with a deficiency of air, 2.25 lb of water will form whether all the carbon goes to carbon dioxide or not.

In Fig. 2, each curve represents the dewpoint, over a range of pressure, for a hypothetical fuel that will produce a given ratio of total products of combustion to water formed in combustion. For any actual fuel, the ratio can be found by:

$$\frac{1 + [(1 + \%\ \text{excess air}) \times \text{air required}]}{\text{Water formed}}$$

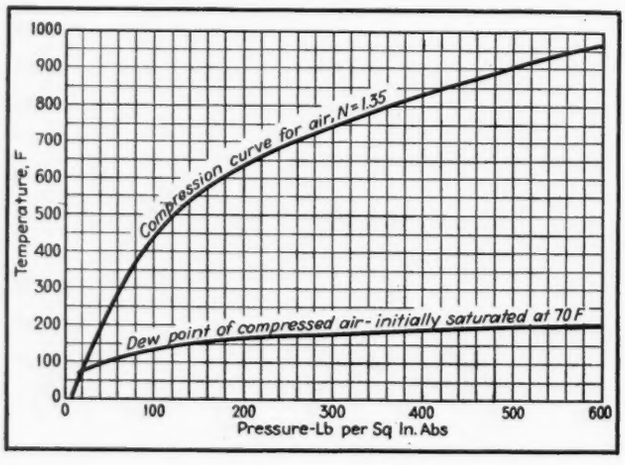
For example, if $CH_4$ were burned with 50% excess air:

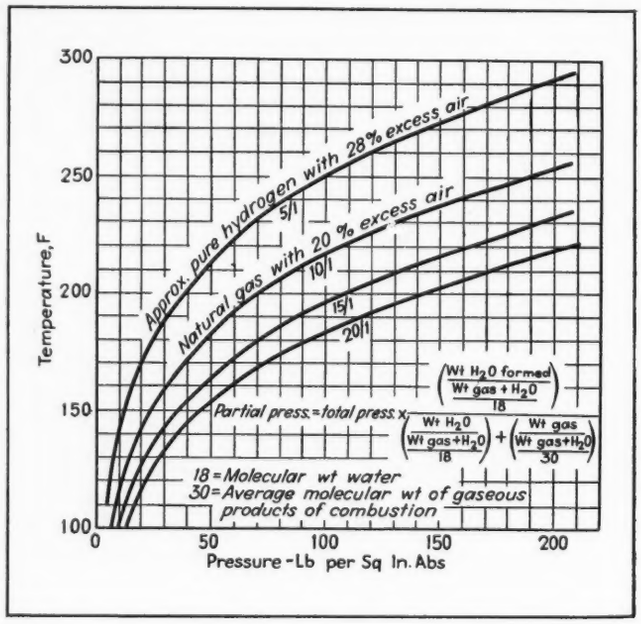
$$\frac{1 + [(1 + 0.50) \times 17.2]}{2.25} = 12 \text{ (approx)}$$

By interpolation, dewpoints for this fuel, burned with 50% excess air, can be found from the chart.

**Fig. 1—Dewpoints for fuels having various ratios of total products of combustion to water formed** ⟶

**Fig. 2—Compression curve for air (n=1.35) and dewpoint temperature for initially saturated air (70 F) at various pressures**





Temperature, F
300
250
200
150
100
Approx. pure hydrogen with 28% excess air
Natural gas with 20 % excess air
5/1
10/1
15/1
20/1
Partial press. = total press. x (Wt H2O formed / (Wt gas + H2O)) / 18
(Wt H2O / (Wt gas + H2O)) / 18 + (Wt gas / (Wt gas + H2O)) / 30
18 = Molecular wt water
30 = Average molecular wt of gaseous products of combustion
0
50
100
150
200
Pressure - Lb per Sq In. Abs

# THE OPERATING ENGINEER

George Edwards
*Advisory Editor*

**Practical Aids**
**Maintenance Hints**
**Questions — Answers**

**Published monthly as an integral part of POWER**

## *It Takes More Than a Bright Idea*
# TO CONVINCE THE BOSS

***Find the best way to make an improvement, show the boss how it can be paid for, then prove you're right—that's Frank Smart's formula at Beth Israel Hospital***

MANY A GOOD IDEA falls by the wayside when it gets to the boss, and many an engineer stops trying when he can't get his scheme over the last hurdle. Often the trouble lies in a failure to take time and trouble to study out the brainstorm, to turn the bright idea into practical, working form. Some times the engineer doesn't put enough effort into figuring ways to do the job at least cost. Most often of all, he fails to understand the problem faced by all managements in these days when money is hard to come by. Convincing the boss of possible savings isn't enough; the engineer must suggest some workable way to fit the proposed expenditure into a tight budget.

### *Gains in Economy*

What can be done by following this formula is shown by the record at Beth Israel Hospital, New York City, where Frank Smart has served as Chief Engineer since 1929, six months after the plant went into operation. In this plant, relatively modern and efficient to begin with, there were no easy pickings in the way of savings. With only modest gains possible, improvements had to be equally modest in outlay. And yet, over the years, this plant's operation has steadily gained in economy and reliability as a result of a series of steps taken on a pay-as-you-go basis. This technically and financially practical program has had the full cooperation of Dr Nathan Ratnoff, Medical Director.

The original plans for the boiler room included 4 Heine boilers (3 of 2310 sq ft and one of 2560 sq ft) arranged with low settings for handfiring anthracite. When the building was completed in 1928, after being under construction for some years, oil burners were installed. These boilers supply steam (175 lb, sat) to three Erie-Ball 4-valve engines driving 250-kw, Crocker-Wheeler dc generators. The engines exhaust into the 2-pipe vacuum heating system. Reducing valves supply 100-lb steam for the laundry, and 35-lb steam for kitchens, sterilizers, etc. Two 25-ton Wittenmeier $CO_2$ compressors, motor-driven, supply refrigeration for icemaking and for two circulating brine systems.

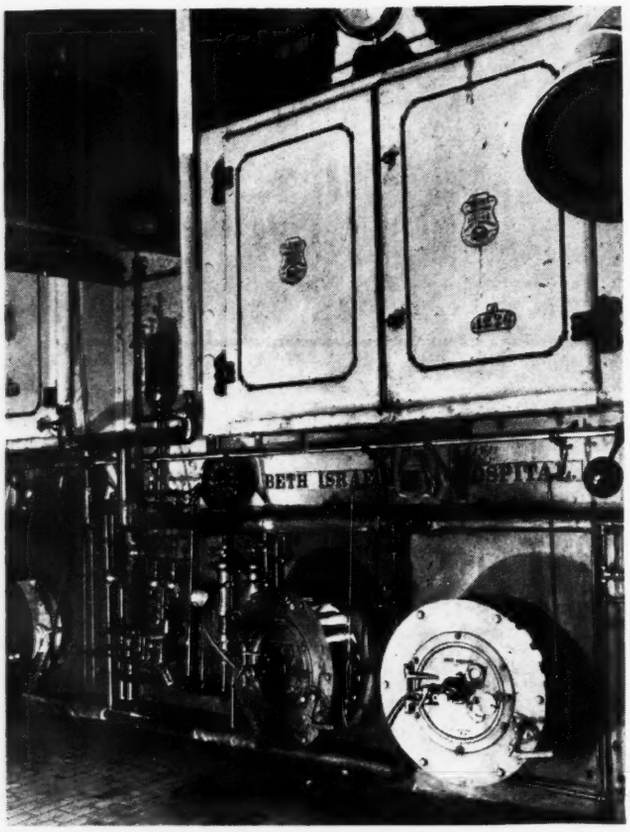
Exhaust from steam-driven pumps, plus some engine exhaust, supplies an open feedheater and five storage-water heaters. Each heater discharges into a different service, operating at a different temperature, all being thermostatically controlled and equipped with temperature recorders.

Weakest link in this typical hospital plant was the firing equipment; the low settings and narrow furnaces meant operating at low ratings to avoid smoke and to keep down brickwork trouble due to flame impingement.

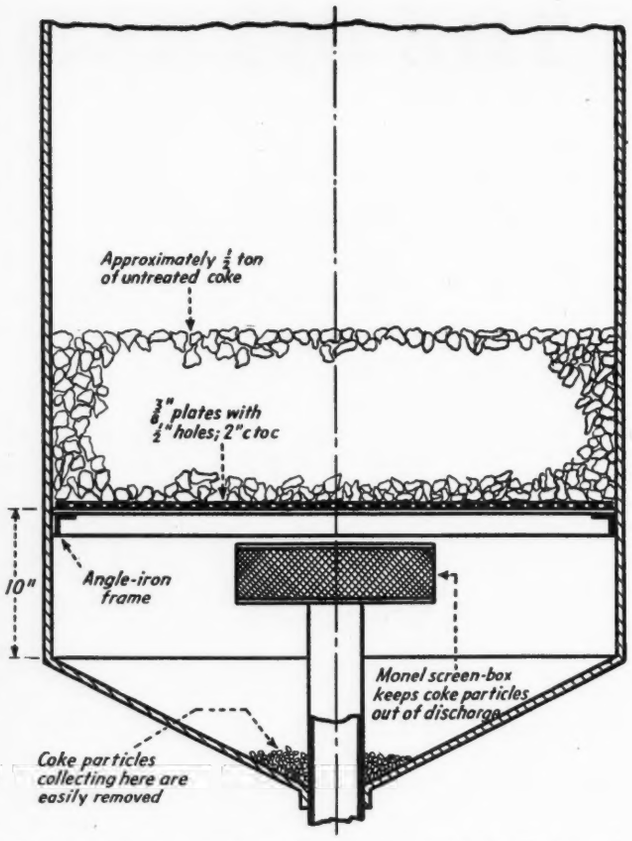
**Chief Engineer Smart and some of the meters that keep him informed about his plant's operation**

This, in turn, meant running two or more boilers on all but the lightest loads at night, and so lowered efficiency. Although the actual seat of the trouble was in the setting and burner arrangement, the first improvement was addition of combustion control.

Back in 1932, at the bottom of the depression, a combustion engineer asked to make a survey to see if savings couldn't be produced by combustion control. Since there was no obligation involved, he was allowed to go ahead. His report showed a possible saving of 5% in fuel, and he was willing to install the equipment at his own expense, to be paid for on an



Setting the new oil burners at an angle in the furnace eliminated sidewall impingement troubles


Approximately ½ ton of untreated coke
¾" plates with ½" holes; 2" c to c
10"
Angle-iron frame
Monel screen-box keeps coke particles out of discharge
Coke particles collecting here are easily removed

Adding a filter section to the open heater helps bring oil in boiler feed down to 3 ppm during heating season

18-month savings contract. Here was a conservative proposition, requiring no cash outlay, one that even the most hard-hearted boss would have a tough time turning down. Incidentally, Frank Smart thinks that if more companies began with a thorough-going study of possible savings instead of making extravagant claims, and then backed the proposition with a guaranteed savings plan, more modern power equipment would be sold.

### *New Oil Burners*

The new controls (Weeks-Merritt) actually paid out in less than the guaranteed period and have been contributing to better economy ever since. However, their installation did nothing to solve the problem caused by the burner arrangement and the low setting. By 1937, industrial oil burners had improved to a point where the old burners could be considered obsolete and replacement was justified. The most economical solution would have been new burners only, but Chief Smart found some difficulty in getting anybody to sell new burners without registers and fronts, even if relieved of responsibility.

Finally, by arrangement with the Coen Co, new burners were tried in the old registers on one of the boilers. Continued cooperation resulted in the loan of new registers also, for try out in new front installed at the hospital's expense. Several months' trials showed good results up to and beyond 170% rating. It was understood that, if the trials were satisfactory, the hospital would equip all boilers in a similar fashion. This was done in 1937-38.

To eliminate some of the troubles from the low setting and the narrow furnace, the new burners went in at a slightly lower point and were pointed a little toward the center of the furnace, to pull the flames away from the sidewalls. Both operators and burner manufacturer feared that there might be some slight chimney action where the flames met, causing impingement on a small section of the lower tubes. This trouble never developed, and the "cocked" arrangement of the burners proved highly satisfactory.

In rebricking the sidewalls, consideration was given to using a special high-quality brick, but the cost for the entire wall was prohibitive. Chief Smart and the burner engineers charted carefully the places in the sidewalls subject to rapid deterioration and the wall was laid up with special brick in these spots and ordinary brick elsewhere. The added cost per boiler was $35.

The new burners and changed arrangement permitting running the boilers at much higher rating, without smoke or refractory troubles, and so made it possible to carry loads with fewer boilers, each working at a more efficient point. This, plus better burner performance, produced a big enough saving to pay the cost of improvements in less than a year. Here again, the idea had been presented to the management in such a way as to make it easy to say "yes". Preliminary tests showed the scheme would produce savings, and the burner company had agreed to accept payment in monthly installments. Somehow, it seems easier to squeeze $100 a month out of a budget than to get $1200 in a lump sum.

### *Saving Laundry Steam*

Engineers in institutions know how laundries and kitchens can "eat" steam. There are two general ways to curb this waste; by metering and charging the departments for every unit used, or by arranging things so that steam and water can't be wasted. The latter method has worked well at Beth Israel, particularly in the laundry.

Three years ago, Chief Engineer Smart installed automatic valves on the laundry's five wash wheels. With hand-operated valves, and one operator

handling the five wheels, more water goes to the wheels than is needed in many cases. Now the operator presets the valve for a given depth of water in the wheel and the valve automatically shuts off the hot-water when the right level is reached. This means big savings in gallons of hot water and equally big ones in dollars.

### *Removing Oil from Exhaust*

Where exhaust from engines goes to a heating system, removal of oil always presents a problem. At Beth Israel Hospital, a baffle-type separator did a fair job of removal but the boiler inspectors always reported traces of oil in the boilers. To eliminate even this slight trace of oil the engineering staff made two low-cost but worthwhile improvements in the fall of 1939. These changes have cut oil in the boiler feedwater from 10 ppm to 3 ppm and the boiler inspector can no longer find "traces" of oil in the boilers. Likewise, checks show less oil in the heating system and in the 35-lb system, than ever before.

The first step in the oil-elimination program involved adding a tray of perforated metal plates about 10 in. above the bottom of the open feed-heater. Plates were sized so that they could be installed through the heater access door. The plates support a layer of untreated coke, about ½ ton, which provides the necessary filtering. The standpipe at the heater bottom extends into the space below the plates and carries a Monel screen box to prevent coke particles flowing out with the water. Because filtering efficiency drops sharply when the coke accumulates oil, operators replace the layer at 6-month intervals, the yearly cost being in the neighborhood of $16 for the ton of coke used.

Utilizing the quick-opening valves salvaged from the wash wheels, the staff built an efficient filter for heating-system returns. The filtering medium consists of a layer of cellulose sponge above one of untreated coke. The picture shows how piping and insulation were saved by careful planning of the piping changes and by care in removing covering so that little or no new material was required.

### *Fire Prevention*

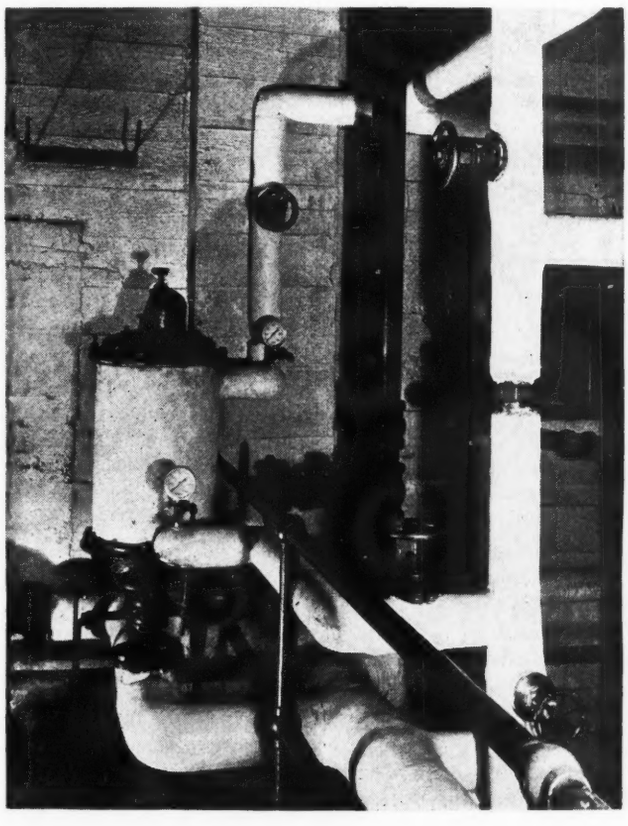
Need for absolute dependability of operation dictated the latest improvement made at Beth Israel. The plant has run since the beginning without any breakdown service, but fires in feeder pull boxes in several N. Y. buildings made Mr Smart and the management feel that an ounce of prevention might be worth a lb of cure. So early this year they installed a Lux $CO_2$ fire-extinguishing system to protect vital points.

From the main cylinder, $CO_2$ is piped to 9 "horns" in feeder compartments and in the main pull box under the floor, carrying the generator leads. Each point has a thermostat, set at 135 F. High temperature at any point causes a gong to sound and all the engineer on watch has to do is turn a quick-opening valve on the main cylinder. This floods the compartments and pull boxes with $CO_2$ "snow," effectively damping any fire. In addition, thermostat action releases pressure on a valve holding open a weighted damper in the duct supplying air to the main pull box, and, through a relay, shuts down the fan motor.

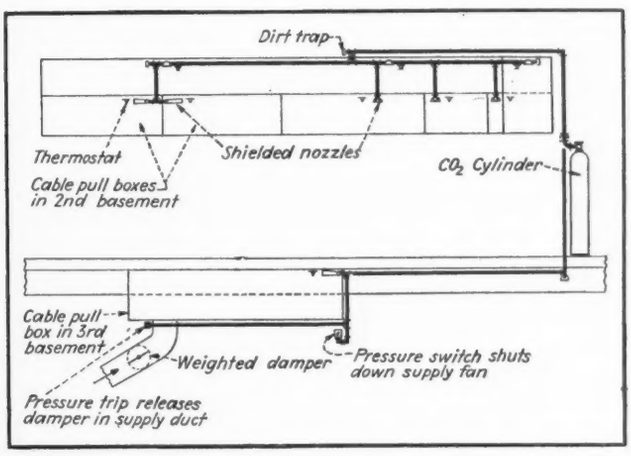
### *Machine Shop*

A well equipped machine shop will pay its way many times over, in Chief Smart's estimation. Aside from power-plant improvements and building maintenance work, the Beth Israel shop turns out many special devices for the various hospital departments. Building oxygen tents, radio-therm units, special X-ray equipment and various other hospital instruments taxes the ingenuity of the engineering staff but they've never been licked yet and are properly proud of several of their elaborate productions.

Even though experience has proved the shop can turn out anything that's needed around the building, Frank Smart believes the secret of making a shop pay lies in knowing when *not* to make something. He knows his costs and overheads, and long years at work of this kind allows him to make a pretty shrewd estimate of the cost of producing a given item. If the same thing or a satisfactory substitute can be bought for less, the shop turns down the job.



**Building this coke and cellulose-sponge filter was another step in the campaign against oil**




**Schematic layout of new $CO_2$ fire-extinguishing system for feeder pull boxes, valuable preventive medicine**

# *The How and Why of*
# DRAFT MEASUREMENT

***Knowing how draft gages work and what draft readings mean can make all the difference between efficiency and waste in the boiler room. W H Pugsley, The Hays Corp, tells about both angles in this article, second of a series***

THE U-TUBE GAGE (Fig. 1) represents the simplest way to measure draft. The instrument includes a glass tube, U-shaped and partly filled with water, and a scale divided into inches. To measure draft or pressure, connect one leg of the tube to the point where the measurement is wanted and leave the other end of the tube open to the atmosphere. Difference in pressure on the two legs will cause the water to rise in one and fall in the other. The difference in levels can be read on the scale, in inches.

To get a differential reading (the *difference* in pressure between *two* points, instead of the draft or pressure at *one* point) connect one leg of the tube to each of the points. The difference between the drafts or pressures at the two points will cause the water to rise in one leg and fall in the other. Again the scale gives the reading in "inches of water," the standard unit for measuring draft in this country.

### *Inclined-Tube Gage*

To avoid the difficulty of reading small values, such as 1/100 in., on the ordinary U-tube gage, an inclined-tube gage (Fig. 3) can be used. This modification of the U-tube magnifies the movement of the liquid in one leg of the gage; the arrangement of the scale makes it possible to take a reading by referring to the level in only one leg.

Errors result if either the U-tube or inclined-tube gage is not mounted level. Other operating difficulties arise from the fact that the water or other liquid used evaporates and the specific gravity changes with the temperature. In general, gages of these types do not lend themselves to modern power plant use except as test gages.

Efforts to produce more satisfactory gages produced the oil-sealed inverted-bell gage and the "dry" or diaphragm gage. In the former, Fig. 4, the draft or pressure to be measured works on the under side of an inverted bell, which is immersed and sealed in oil. The bell hangs from a beam with a weight for a counterbalance. Differences in the draft or pressure cause the beam to take different positions; linkages and levers amplify the movement to a pointer on a scale reading in inches of water. The length of the beam, the amount of the weight, and its arc of travel determine the scale of the instrument. Adjustment is effected by moving the suspended weight.

The oil-sealed gage represents a decided improvement over the inclined-tube gage and makes possible the simpler pointer-and-scale type of indication. However, this gage also uses oil, which evaporates and must be replenished. The scale should be several times greater than required for actual operating purposes, to avoid having the oil blown out when the soot blowers operate, a high draft occurs, or high fan pressure is needed. To seal against the high drafts and pressures used on present-day steam generators requires special construction.

### *Dry Gage*

The dry or diaphragm gage, developed in 1925, uses a flexible animal membrane known as colon leather (sometimes called Goldbeater's Cloth) in place of the oil-immersed bell. In a typical instrument, a die-cast metal housing encloses a diaphragm of this soft, flexible but tough material, reinforced with light-weight metal plate. There is enough slack in the diaphragm to allow a free movement at all times. A spring opposes the movement caused by the draft or pressure and the resulting diaphragm motion is transmitted directly to an indicating pointer, on a scale reading inches of water.

This simple gage is compact, easily installed, and can be built for any range of draft, pressure, or differential. It will stand considerable overload, is both sensitive and accurate and requires no attention other than an occasional easily made zero check. The dry gage finds wide use in boiler plants and because it can be handled easily and read clearly it makes a good portable test instrument.

### *Why Draft Gages?*

Any furnace or boiler needs one or more draft gages; the number, and the points at which measurements are taken depend on the type of boiler and furnace, on the nature of the fuel and the burning equipment, and on the number and location of draft fans.

There are really two kinds of draft and pressure measurements: those needed for acceptance and check-up tests and those needed to help the operator get best results, day in and day out. As an example of the first type of draft measurement, assume the manufacturer guarantees that pressure drop through the boiler will be less than a certain amount. Naturally, the purchaser wants to check on this guarantee, so when the boiler is erected, draft readings are taken at connection points provided in the setting by the manufacturer. Now assume that the boiler operates for some time and the engineer begins to suspect that some of the gas passages are clogged. A check-up test, made with a draft gage, will show whether or not the draft loss through the boiler has increased because of soot or slag deposits.

With a portable draft gage, the boiler-room engineer can become a first-class detective, running down all sorts of troubles that cause waste. Careful,

systematic checking of draft at various points will show up such things as leaking baffles and air heaters, leaky fittings, warped bypass dampers, clogged gas passages in superheaters, economizers, or air heaters, abnormal slag or scale deposits, soot or dirt accumulations.

The boiler-room engineer is most familiar with draft gages as an aid to efficient day-by-day operation. Like test and check-up measurements, these readings should be accurate, but their real importance lies in the relations between them, under various load and operating conditions.

### *Aid to Efficiency*

Control of air supply serves as a good example of the way draft readings help to secure efficient operation. Air is free but using more or less than is needed for good combustion costs money. For example, if 12 lb of air to one lb of fuel forms the most economical ratio, then every lb of air above the 12 lb means greater fan capacity needed and more power to drive the fans, as well as more stack and breeching capacity. This excess air means less efficient heat absorption, higher exit gas temperatures, and, in general, less efficient steam production.

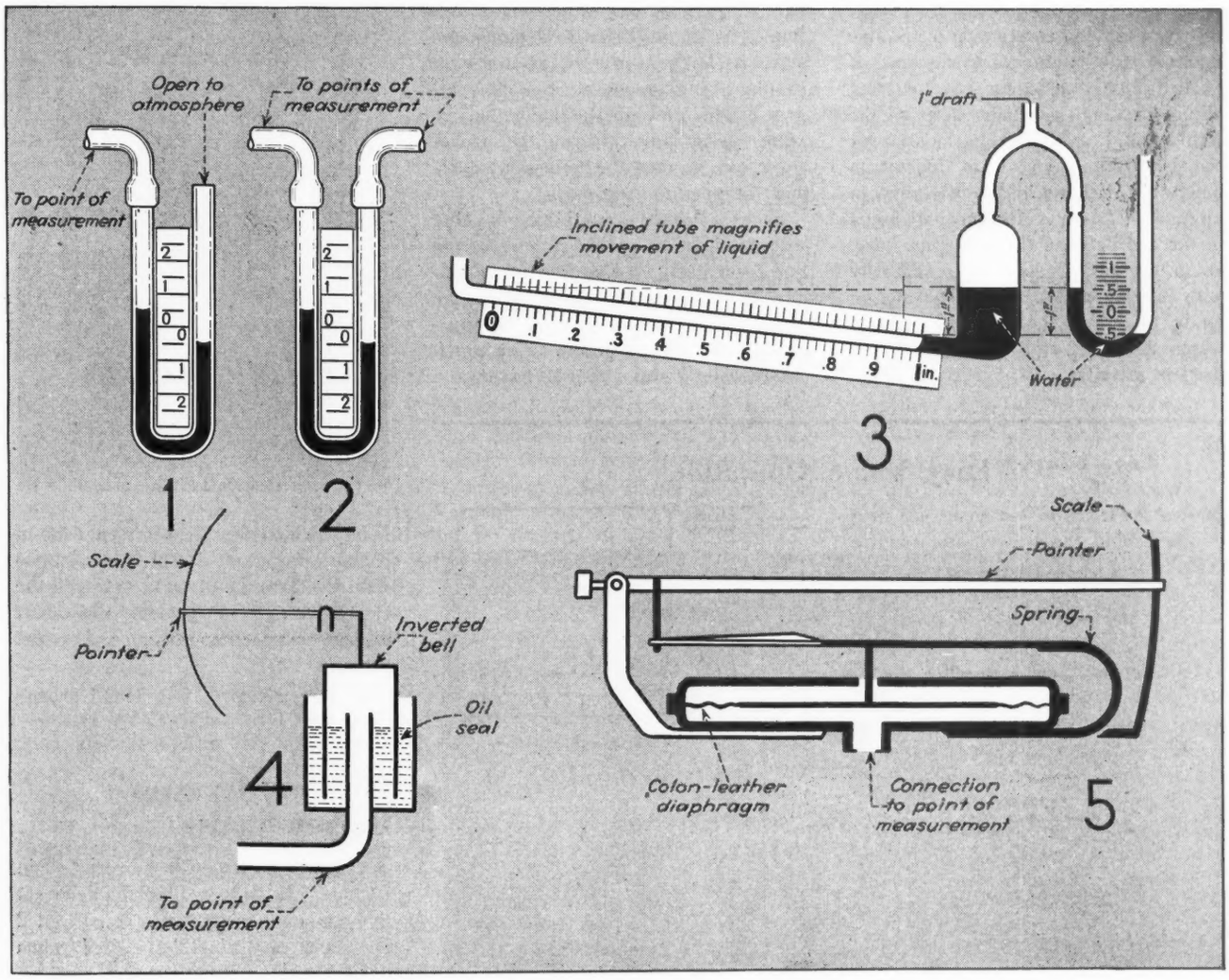
Suppose we supply only 8 lb of air per lb of fuel? Again combustion efficiency suffers because there isn't enough air for complete burning of the fuel. This means that there will be CO in the flue gas and free carbon going up the stack and into the ash pit. All these are unnecessary losses, that could be eliminated by measuring the air supply to insure exactly the right amount, whether it is 12 lb as assumed here, or some other amount for a different fuel and furnace.

Not only must the operator control the quantity of air, he must regulate its distribution, so that it goes where it will do the most good. Typical examples of such air-distribution control can be found in zoned stokers and multiple-burner, pulverized-coal-, oil-, or gas-fired installations. For the whole furnace, the rate of air flow to fuel feed may be correct, but unless the air is properly distributed so as to come in contact with the fuel in the correct proportions at all points, some combustion efficiency will still be lost. Draft or pressure readings represent the best guide to the operator in securing good air distribution over the entire fuel bed.

### *Location Important*

So we see that draft gages are essential to good boiler and furnace operation. But unless the right number of gages are installed, and in the right locations, the amount of good they can do is limited. The next articles of this series will show where to put draft gages for best results on various boiler and furnace combinations.

**Figs. 1, 2—The ordinary U-tube makes the simplest draft instrument; with one side open to the atmosphere the scale reads draft, with both legs connected, the scale reads differential draft. Fig. 3—The inclined-tube gage permits closer reading by magnifying the movement of the liquid. Fig. 4—Oil-sealed, inverted-bell draft gage; linkages and levers amplify movement to a pointer reading in. of water. Fig. 5—"Dry" or diaphragm draft gage, developed in 1925**



# PRACTICAL AIDS TO OPERATION

## Swing Joints Accommodate Expansion

PIPELINES handling heavy liquids that need constant heating to maintain fluidity, require provision for a large range of expansion and contraction of the line due to wide temperature changes. A packed joint, with a long section sliding within packing, is usually used on the liquid line. If a similar joint is used for the jacketing steam, it is difficult to maintain the liquid and jacket pipes in alignment. The use of swing ball joints in the ties between the jacketing lines, as in the photo, may cause difficulty with lagging maintenance. The motion tends to break the covering, permit water to enter, and disintegration to proceed rapidly.

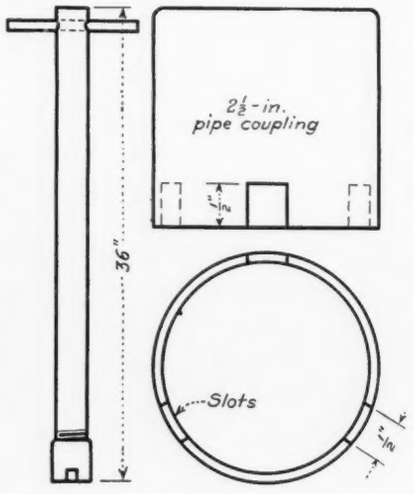
The engineers of one plant using such a system leave a cup-shaped depression in the jacket lagging around the swivel joints, as at *A*. Prior to lagging the swing itself, these cups are given a light coating of high-temperature, waterproof grease. This prevents the lagging on the swing from adhering to the jacket cover, yet permits the necessary movement between the two parts.

Such a formed joint in the lagging will stand up in service as long as the line cover itself. It also presents a definite line at which the covering may be broken off in case of repair or adjustment to the swivels or the swing itself.

*Longview, Texas* ELTON STERRET

## Easy Valve Operation

BLOWOFF VALVES in our plant are in a trench behind the boilers and require one to kneel in an awkward position to operate them. We overcame this difficulty by making the tool shown in the figure, from two sections of pipe and a coupling. The 2½-in. coupling is slotted at its lower end to fit over the valve-wheel spokes. Into this coupling we screwed a 3-ft length of extra-heavy pipe with a section of ¾-in. pipe through a hole near its top end. The ¾-in. pipe serves as a turning lever when opening or closing the valves. This simple tool has made a disagreeable job an easy one.

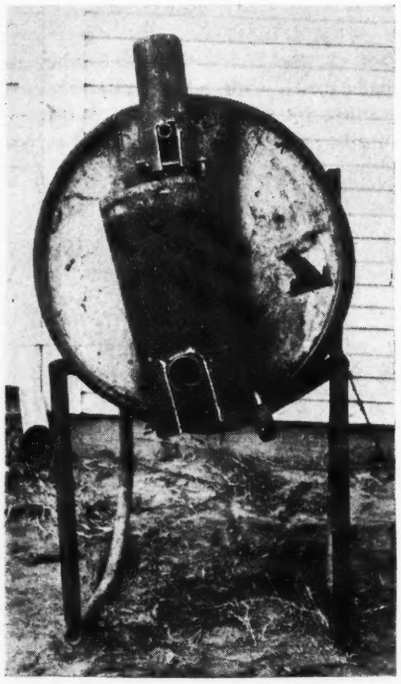



*Cleveland, Ohio* A R CIOTTI

## Pilfer-Proof Covers For Containers

ORDINARY FAUCETS or valves screwed into the two openings in a steel drum appear to be theft-proof when padlocked. These can readily be unscrewed, however, from the threaded apertures and the drum's contents stolen. One plant guards its solvent supply with a pair of pilfer-proof covers that fit down over the valve handles. These guards are locked in place by padlocked-in bars passing through slots near their bases.

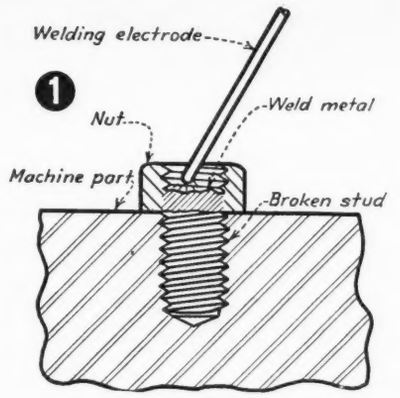
Double guard against unscrewed valves is obtained by making the cover pipes long enough to interlock, neither being able to complete a turn without striking the other. A wide plate is also welded across the drum in line with the two openings to protect the short nipples connecting drum and outlet valves.

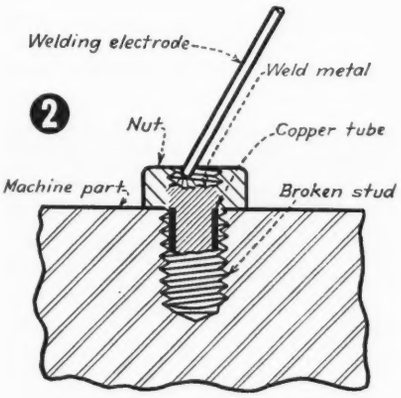


*Kilgore, Texas* C C LYNDE

## Welding Removes Broken Studs

WHEN A STUD or cap bolt breaks off in its hole, you have a difficult job to get the remaining piece out. Figs. 1 and 2 show two methods I have used, when




an electric welding machine was available. If the stud is broken off flush with the surface use method Fig. 1. Take a nut the same size or slightly smaller than the stud and place it around the broken section. Now, using the smallest available size ($\frac{3}{32}$ in. or $\frac{1}{8}$ in.) heavily-coated electrode, weld the nut to the threaded portion of the stud. After welding allow the work to cool and then tap the nut lightly with a hammer. With a tight-fitting wrench, work the nut right and left until the threads become loose. Then remove the stud.

If the stud has broken down into the threaded hole, it can be removed as in Fig. 2. Place a copper ferrule that fits snugly into the hole on top of the stud to protect the threads. Cut the ferrule flush with the top of the hole. Put the nut into position and weld it to the stud, after which it is removed as explained in the first method described above.

The secret of this method is that welding heat expands the broken portion of the stud in the hole. During expansion, rust holding the threads tightly is cracked and compressed. When the stud cools it is free of its bond and is relatively loose and easy to remove. Otherwise, you have the devil's own time getting the stud out.

*Kansas City, Mo.* T B JEFFERSON
*Jefferson Wire & Iron Works*

## Pump-Cylinder Liners Should Not Be Grooved

IN THE WATER CYLINDER of a boiler-feed pump I discovered that the liner was cracked and its surface corrugated circumferentially, Fig. 1. When the liner was taken out of the cylinder we found that grooves had been cut in its outside surface, Fig. 2, evidently because the liner fitted too tightly in the cylinder. As a result, pressure inside the liner expanded the thin metal sections to produce the corrugations.

I have been told that cutting grooves in pump-cylinder liners is done by some engineers. This I consider poor practice. If the liner is too large, a few thousands can be polished off its outside surface to make it fit properly. The experience mentioned indicates that they should not be grooved.

*New York, N.Y.* S M ELONKA

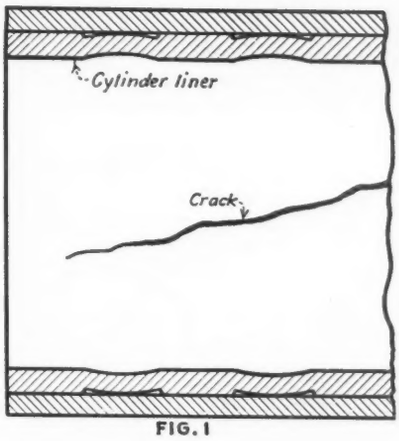



FIG. 1

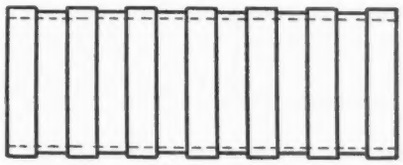


FIG. 2

## We Build an Electric Welding Set

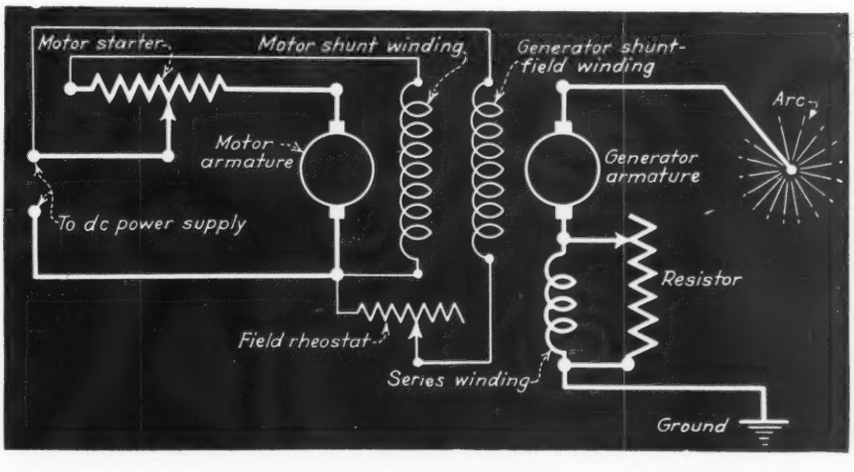
WHEN OUR REQUEST to the head office for an electric welding set failed we decided to build one. A moving-picture theatre motor-generator set, consisting of a dc motor driving a 11-kw, 115-volt, dc compound-wound generator, was the main part of the set. We chose a dc motor-driven set because many of our power-plant auxiliaries are dc-motor driven and dc power is available everywhere in the plant.

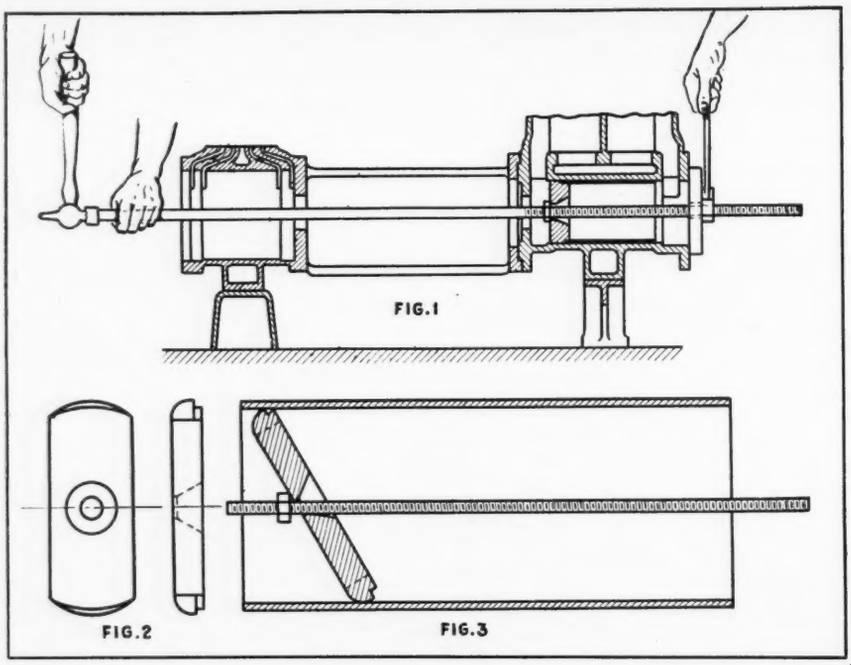
We connected the generator shunt-field winding to the dc power supply through a rheostat (see diagram) as it gave quicker voltage recovery than when these coils were connected across the generator. The series winding was connected to buck the shunt winding and bypassed with an adjustable low-resistor. This resistor was made from an old 40-hp motor starter with copper wire substituted for the resistance wire.

After a few trials with the shunt field and bypass resistances suitable generator characteristics were obtained. By adjusting the two resistances it is possible to obtain any desired arc current and voltage, giving the operator control of arc heat and penetration. We mounted the motor-generator on an angle-iron frame on two rubber-tired wheels obtained from an automobile junk yard.

We have used this set all around the plant for welding hoppers, piping structures and for repairing broken and worn parts. All this to the mystification of the purchasing agent who is trying to find out where we got our welding set after he refused to buy one.

*New Castle on Tyne, England*
T D OSWALD






## Cylinder Liners Removed in One Piece

WHEN RENEWING LINERS in reciprocating pump cylinders, you may find that the worn ones are difficult to remove. A common method of removing the old ones is to split them with a hammer and cold chisel. In our plant we take the liners out in one piece, see Fig. 1. The strong back is made in the form, Fig. 2, with a funnel-shaped hole through its center. The latter permits passing the strong back through the liner, Fig. 3, to get it in position against the end of the liner.

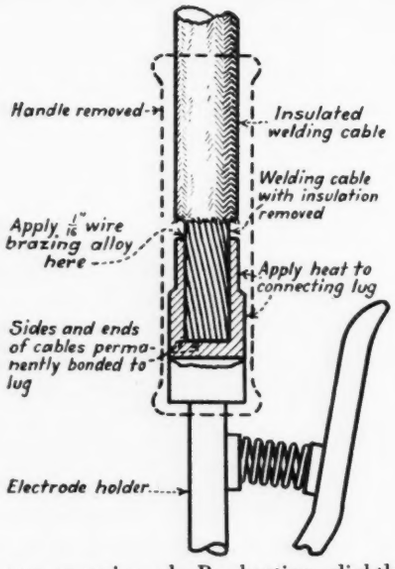
To take out the liner, first tighten the nut on the rod to give a good pull. If this does not start the liner, then hit the free end of the pull rod with a hammer. I have found that tightening the nut and using the hammer will start any liner. One advantage of removing the liners in one piece is that if they are not standard they may be rebored in a lathe and replaced.

*New York, N. Y.* S M ELONKA

## Electrode Holders Cool to Handle

WHILE ARC WELDING with a ¼-in. diameter rod an operator was bothered by excessive heat in the electrode-holder handle. An inspection showed that the soft soldered connection between the holder and welding cable had melted. Naturally, the poor electrical contact caused excessive heating. The trouble was cured by rejoining cable and holder with silver brazing alloy.

The solder was first melted off the cable and holder. Then these parts were cleaned thoroughly and fluxed with a low-temperature brazing flux. After reassembling the joint, heat was applied with an oxy-acetylene torch, concentrating it upon the connecting lug of the electrode holder. As the lug and cable fitting came to a dull red heat, a low-temperature brazing alloy was applied as indicated in the drawing. No further trouble with heating


Handle removed
Insulated welding cable
Welding cable with insulation removed
Apply 1/16" wire brazing alloy here
Apply heat to connecting lug
Sides and ends of cables permanently bonded to lug
Electrode holder

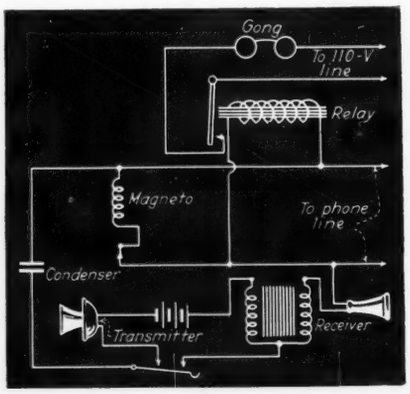
was experienced. By heating slightly above the flow point of brazing alloy, one can take a joint apart easily if necessary.

*New York, N. Y.* F T VAN SYCKEL

## County-Line Phones for Plant Service

TELEPHONE COMMUNICATION between isolated sections of the same department can often be facilitated by installing phones that are entirely independent of the main-plant switchboard. Such a system has many advantages, especially where close coordination of activities is desired. Whether used to facilitate normal transaction of business or to aid in handling emergencies, service is quick and sure.

Where long distances are involved the old-fashioned so-called "county-line" phone with a crank-controlled magneto for ringing is frequently employed. In a large southern plant, communication



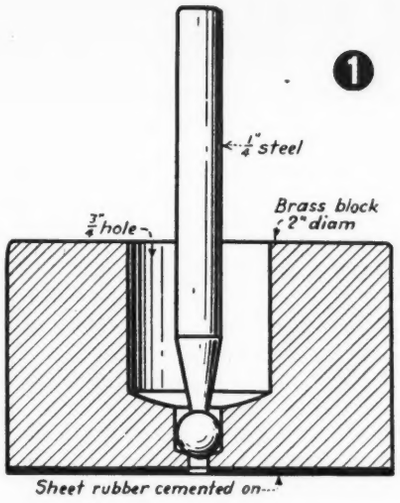

between remote pumping stations and power plant is provided by phones of this type. Because of machinery noises at the power plant, a relay closes the ringing circuit to sound a large 110-volt gong easily heard at any point around the floor on which the phone is located. To enable operators to distinguish between primary- and secondary-phone calls, a similar relay on the primary-phone system sounds an electric horn. This phone system has proved to be a great time-saver when inspecting and maintaining the pumping plants.

*Bethesda, Md.* S H COLEMAN

## Beam Compass Becomes Circular Glass Cutter

THE BEAM COMPASS described on page 101, August POWER, interested me so much that I made one. Then, it occurred to me that the idea could be applied to a circular glass cutter.

I used the beam and one of the point holders, replacing the point with a ball center, Fig. 3, for which I made a center block from a piece of 2-in. round brass stock. Fig. 1 shows construction of this block. A piece of sheet rubber is cemented to the bottom of the block

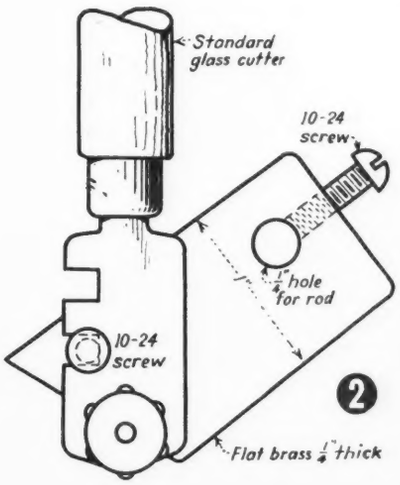


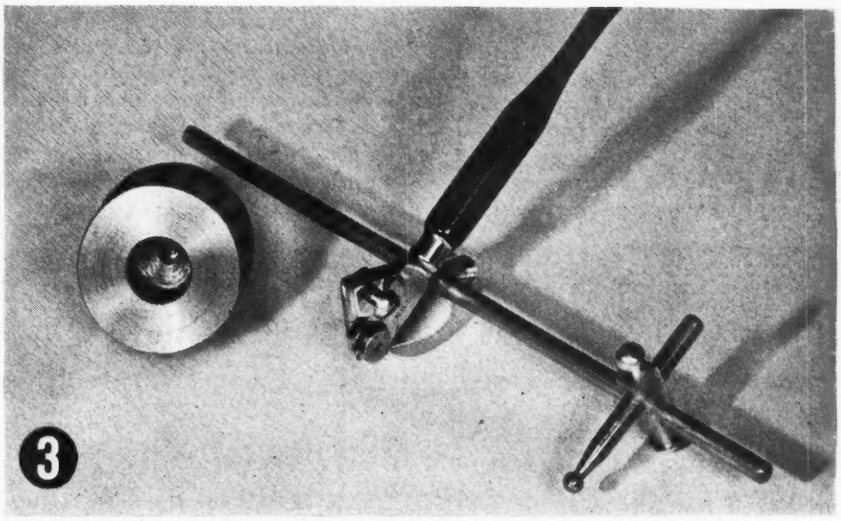

to prevent it slipping on the glass.

I bought a roller glass cutter and fitted it to a brass holder, Fig. 2. This holder is so shaped that the cutting wheel is about in line with the ball center when bearing true with the beam horizontal, Fig. 3.

When cutting the glass circle, bear down on the ball center in the block. Roll the cutter back and forth to make a deep cut in the glass, Fig. 4. To break out the circle, scratch a tangent to the circle and break off the piece. Then scratch another tangent at right angles to the first and break this piece off. Continue around the sheet. Next scratch a tangent on the four corners and break them off. The small remaining corners can be broken off clean to the circle with the cutter jaws, by careful handling. If you are not used to handling glass you had better make your first trial on a waste piece.

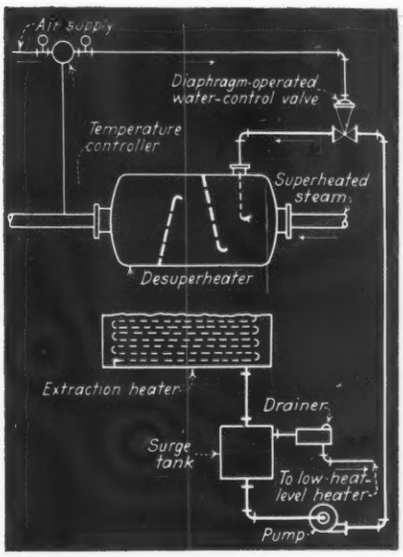
*Chicago, Ill.* J B MULLINS



## Water Supply for Desuperheaters

DESUPERHEATERS using boiler feedwater to reduce steam temperature are very sensitive to any solid matter that may be left behind after the liquid is evaporated. Not only does the accumulation of this material have a tendency to increase pressure drop through the equipment, but it also obstructs the normal flow paths of steam and water, frequently affecting temperature regulation and desuperheating efficiency. Then, too, impurities that do not lodge in the desuperheater may be carried into the steam lines to interfere with valve operation, reduce the effective internal diameter of the piping, etc.




In our plant we experienced so much trouble with our venturi-type desuperheaters, due to scale incrustation completely plugging the steam passages every month or so, that it became necessary to substitute pure condensate for the boiler feedwater formerly used. To do this, a surge tank and small pump taking hot condensate at 75 lb pressure from the drips of an extraction feedwater heater was installed, as in the figure, to handle the desuperheater-water demand. The original water-supply piping from the boiler-feed system was left in place to be used during periods when the heater was out of service or during repairs to the pump.

*Atlanta, Ga.* H P CLEARY

# READERS' PROBLEMS

## *Questions from Our Readers*

### Cleaning Boiler Tubes

#### *Question 1*

DRAFT LOSSES *caused by fuel deposits on tubes force us to bring down our boilers for cleaning at intervals of from 6 to 12 weeks. These deposits consist of soluble salts when we burn hot asphalt, or of lime and calcium sulphide when we burn fuel oil. We alternate these fuels according to market conditions.*

*In the past we cleaned the exterior surfaces of our water-tube boilers by punching and blowing with 90-lb air, allowing the loosened ash to fall to the furnace floor, where it is scooped away. Recently we started using water to wash the tubes. The water softens the ash, dissolving a portion of it, making the boiler easier to clean. In addition it reaches otherwise inaccessible surfaces and cleans to the metal surface. We allow the furnace to cool thoroughly before using water and heat it up very slowly afterwards.*

*We wonder whether this injures the furnace settings and baffles. Does the water fall into small crevices where it is trapped when the furnace begins to expand as it warms up, so that steam formed must burst through? Or does the water evaporate before the small crevices and pores close?*

*Occasionally load conditions are such that we cannot shut down a boiler for cleaning, so we wash the tubes carefully with a limited amount of warm water which evaporates before it can fall into the hot furnace. We are careful to avoid the baffles. Are the stresses set up in the metal of such a nature as to make this practice dangerous?*—DF

### Water in Engine Cylinder

#### *Question 2*

WE HAVE *a single-valve high-speed engine supplied with steam through a pipeline about 250 ft long. There is a standard-size separator in the steam line, but we often have trouble from water getting into the cylinder. This once caused a crack-up when the engine was started. How can we prevent this trouble?*—DLW

SUITABLE answers from readers will be paid for if space is available for publication. Answers accompanied by practical drawings or photographs will command additional pay.

### Coal Weighing

#### *Answers to July Question 1*

#### *The Question*

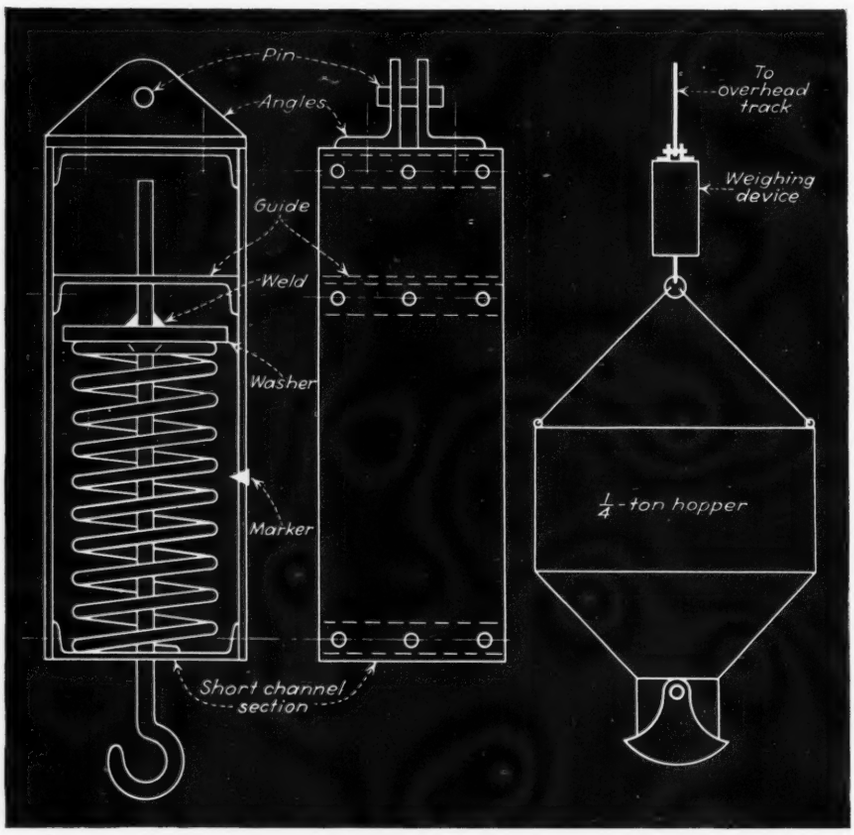
IN OUR PLANT, *coal is brought out of the bunker in a ¼-ton bucket which rides on an overhead track. Our consumption is about 3 tons a day, but on weighing some of the buckets I have found that instead of there being ¼ ton in the bucket, the contents have weighed anywhere from 600 to 740 lb. This puts a sizeable error in any calculations we make regarding coal consumption. How can we rig this bucket to weigh the coal or to indicate when it holds ¼ ton?*—LF

### Make a Spring Balance

IF LF'S OVERHEAD TRACK, or monorail, is anything like the usual arrangement, he should be able to put some sort of a spring balance into the supporting arrangement. The only thing that might prevent this would be lack of headroom, and this doesn't seem likely if an overhead system is employed.

The sketch shows a form of spring balance that would be relatively simple to make. It consists of a frame built up of plate and short lengths of channel iron, bolted together. Other constructions are possible, but this seems simplest to make with the usual limited shop facilities. The major item is a heavy spring (good for the load plus the weight of the bucket plus a small safety factor so the spring doesn't set down solid under the load). The bucket hangs on a rod, with a hooked end; a square washer, welded to the rod, transfers the weight to the spring. An intermediate channel section acts as a guide for the rod, at the upper end. Two angles form a fastening at the top.

The simplest procedure would involve loading the bucket with exactly 500 lb, in whatever form is easiest, and measuring the set of the spring. An easily visible marker should be placed on the side at this point. Then it is only necessary for the fireman to watch the washer as he loads coal; when the washer and the marker line up, he's got the right amount.



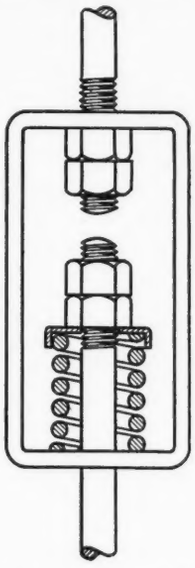
If LF wants a more complicated arrangement, he might wire up a signal light or an alarm bell so that when the washer gets down to the marker the fireman gets automatic warning.

The right-hand part of the sketch indicates one way such a spring balance might be installed. If there is no headroom, LF might work out some offset version of the gadget shown; one that would take less vertical space.

*Pittsburgh, Pa.* J F McHANRAHAN

## Two Solutions

WITHOUT KNOWING the exact details of LF's setup, it is possible to make only general suggestions. However, here are two stunts that would be worth a try. Although it would mean a little more operating trouble and take more of the fireman's time, the bucket could be filled level and weighed just once, for a check. Then, if the fireman is careful to level the bucket each time he fills it, the error mentioned by LF could be reduced. Of course, the size and kind of coal used would alter the weight



slightly from time to time, but this way would be more accurate than the present setup and has the merit of requiring no expenditure.

It might pay to buy or salvage a spring pipe hanger of the type shown. The spring would have to be suitable to support the bucket plus its load. By putting exactly 500 lb in the bucket, it would be possible to find the deflection of the spring and mark it. Then all the fireman would have to do is fill the bucket until the spring settles the right amount and he would have a load that would be quite close to 500 lb. It should be possible to insert a hanger such as that shown into the suspension system of the bucket, without much trouble.

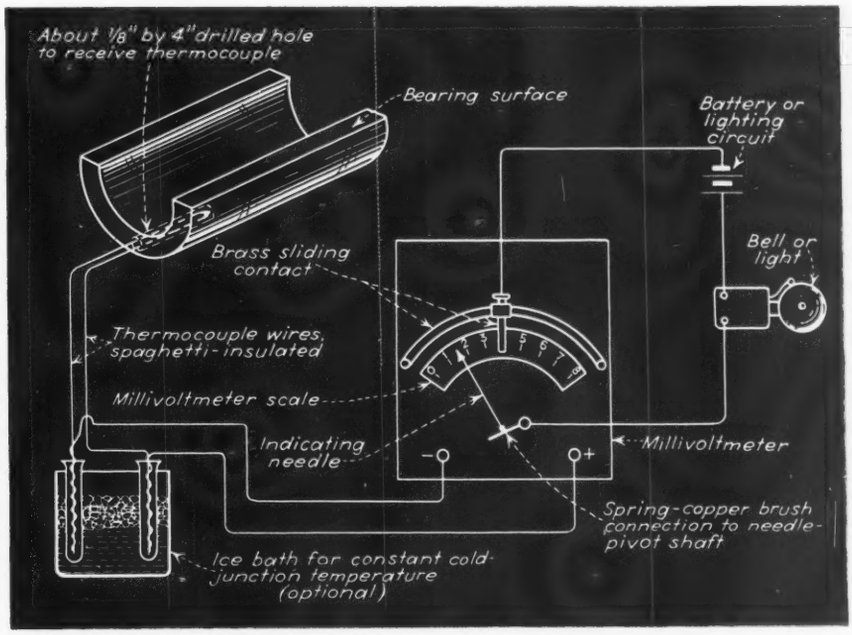
*Brooklyn, N. Y.* T Z ZEKUTHY

## Measure Deflection

I CAN PICTURE all kinds of overhead tracks and car arrangements, but not knowing what structural changes are possible, I can't offer many specific suggestions. Apparently a scale in the outlet from the bunker or somewhere else is out of the picture for one reason or another, as well as any structural modifications to the handling facilities.

Accepting these limitations, the field narrows considerably. My guess at the answer is to find some part of the structure which deflects appreciably under the load of the car and coal and then to hook an extensometer (indicating gage) between that point and a relatively fixed reference point.

*New York, N. Y.* R C ROETGER




## Alarm System for Hot Bearings

### *Answers to July Question 2*

### *The Question*

WE ARE HAVING *trouble with bearings on heavy rolls getting hot and in some cases burning out before we discover what is happening. Can* POWER *readers tell me how to build a simple device that will give an alarm or indicate when the bearing temperature reaches the danger point?*—RWO

## Thermocouple Alarm

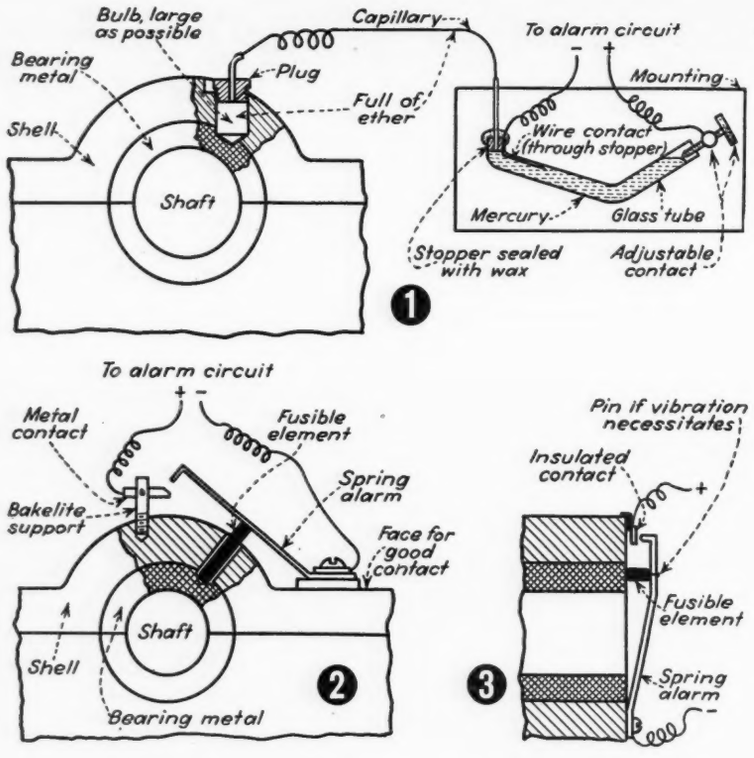
I SUGGEST that RWO use a chromel-alumel (Hoskin's alloy) or an iron-constantan thermocouple, connected as shown in the sketch. It will be necessary to connect the couple wires to a high-resistance (500 to 2000 ohms) galvanometer or millivoltmeter. A sliding contact can be built around the meter scale to set the circuit to close at any desired temperature. One wire from a set of batteries or a lighting system can be connected to the sliding contact; the other wire to the pivot post of the indicating needle through a spring-copper brush. When the bearing heats up, the needle will deflect an amount proportional to the temperature rise until it makes a contact with the slide. This will close the circuit and give the desired warning.

If the plant is air-conditioned or if room temperature stays fairly constant, no ice bath is required to maintain a constant cold-junction temperature. The highest bearing temperatures permissible with normal lubricants should certainly not exceed 212 F, which gives a millivolt reading of about 3.87 with a cold-junction temperature of 32 F, or 3.10 mv with a cold-junction temperature of 77 F (both for chrome-alumel couples).

*Tulsa, Okla.* B D OSBORNE

## Two Methods of Making Alarms

I SUPPOSE I ought to mind my own business, and roll bearings certainly aren't my business, but when I read RWO's question in July POWER I got a brainstorm I couldn't suppress. Per-




haps the obvious way to provide a high-temperature alarm for these bearings would be to use a thermocouple connected to a sensitive galvanometer which would close an alarm circuit when a certain temperature was reached. But that, as efficiency experts say, would be too simple.

One of my ideas (I have two), involves making a pressure thermometer to close an alarm circuit. The first sketch shows what I have in mind. Drill a hole through the shell into the bearing metal, to form the thermometer "bulb" and connect to a V-shaped glass tube with copper capillary tubing. The bulb and capillary are filled with ether and the glass tube with mercury. Incidentally, fill the bulb before attaching the capillary, which also should be filled before it is connected. An adjustable contact completes the gadget.

Operation is obvious. Increased bearing temperature causes expansion and vaporization of the ether; this, in turn, causes an increase in pressure on the mercury column, forcing it against the contact and completing the alarm circuit. Decreasing the diameter of the mercury column will increase the sensitivity of the device but will also reduce the size of contact that can be accommodated. If this is made extremely small it may be necessary to use a relay circuit to actuate the alarm.

The second sketch illustrates a simpler method of doing the job and it might prove entirely satisfactory if the temperature limit is such that a suitable material can be found for the fusible element. This is intended to melt or at least soften when the temperature becomes excessive, allowing the arm to spring down, closing the contact in a conventional alarm circuit. Rose's metal, Wood's metal, some similar bismuth-base alloy, or a non-metallic material like sealing wax might do, depending on the physical arrangement and amount of heat transmitted to the element.

The third sketch suggests a variation of the second, the object being to eliminate the hole in the bearing shell, which might not be permissible.

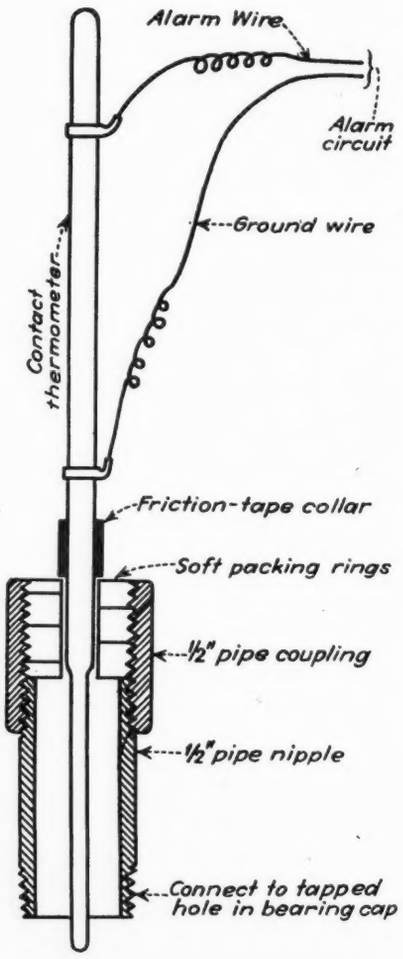
*New York, N. Y.* R C ROETGER

## Suggest Glass Contact Thermometer

THERE ARE MANY DESIGNS of electric alarm thermometers and thermostats on the market which offer wide adaptability as regards location, durability, accuracy, and other service conditions. However, the simplest and least expensive type of contact thermometer consists of a plain glass stem with two contact wires fused into the glass, one for the ground connection and the other for the alarm lead, which can be set at a pre-determined danger point. The alarm circuit can be operated by a storage battery or other low-voltage system and directly connected to bell, buzzer, horn or light. By paralleling circuits any desired number of thermometers can be connected to a single alarm.

The sketch shows the method of installing the thermometer and protecting the stem against breakage. The pipe nipple should be screwed into a hole drilled and tapped in top of the bearing cap, with the bulb in close proximity to the shaft. In some machines, a rise in lube-oil temperature will warn of impending bearing trouble, in which case the bulb may be immersed in oil.

*Fresno, Calif.* E H CARLSON




## Inexpensive Alarms Do the Trick

RWO COULD BUY THERMOMETERS made especially for bearing-temperature indication, suitable for installing in a bolt hole, provided one is available near the bearing. These, of course, give only a sight reading. RWO does not state the type of bearing, though probably babbitt, and evidently he wants an inexpensive alarm-giving device. The above-mentioned thermometers would run to several dollars a piece.

I suggest that RWO make up a sufficient number of devices similar to those shown in the sketch. These work on the principle of the spring-loaded glass-bulb breaker on automatic carbon-tetrachloride fire extinguishers. The effect of temperature on a solder alloy of the correct composition actuates the device. For an open-circuit

*(Continued on page 138)*

# *Figuring Boiler Efficiency*

By PHIL SWAIN

► BOILER EFFICIENCY is easy to figure. The formula is the same as that for the efficiency of practically any other piece of power equipment, namely: *Efficiency is the useful energy output divided by the energy input.*

If you get out three-quarters of what you put in, the efficiency is ¾ or 0.75 or 75%. In the case of a boiler unit, you feed in Btu (British thermal units) in the form of coal, oil or gas. You get out useful Btu in the form of steam.

Boiler efficiency can be figured direct from the total fuel burned in a given period and the total water evaporated in the same period. It is more common to figure, first, the evaporation per pound of coal fired and then the efficiency from this.

### *Example*

For one calendar month of regular operation in a certain plant, the coal consumed is 682,000 lb, and the steam generated is 6,411,000 lb. What is the actual evaporation per pound of coal? First, the actual evaporation per pound of coal fired is 6,411,000 ÷ 682,000 = 9.40 lb. Then, Boiler efficiency = Useful Heat Output ÷ Heat Input = Heat to make 9.4 lb of steam ÷ Heat Content of 1 lb of coal.

For rough estimates of efficiency the heat content of the coal may be taken from the statement of the company supplying the coal. For accurate work the operator must collect a good average sample of the coal and send it to a laboratory for testing. Let's say the figure is 13,260 Btu per pound of coal as fired. Then, Boiler efficiency = Heat to make 9.4 lb of steam ÷ 13,260.

Note carefully "*heat to make* steam" is not the same as "*heat in* steam." You cannot credit the boiler with all the heat in the steam leaving the boiler, because some part of it was in the water fed to the boiler. The boiler unit can be credited only with the heat *put into* the water and steam by the boiler.

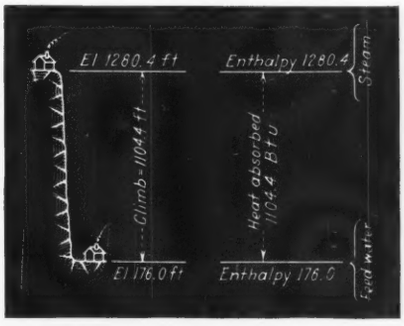
All figures for "heat" in water or steam, as given in the steam tables, are measured above water at 32 F. That is the zero point for heat content, just as sea level is the zero point for elevations shown on a map.

To compute the vertical distance climbed in going from one locality to another, you take the difference between their elevations, both measured above sea level. To compute the amount of heat required to convert one pound of water at the feedwater temperature into steam at the boiler-outlet pressure and temperature, you subtract the "heat" in the water from the "heat" in the steam, both measured above water at 32 F as given in the steam tables.

An example will make this clearer. Suppose the steam is delivered at 179 lb g pressure, and superheated to an actual temperature of 520 F. First find the *absolute* steam pressure by adding 15 lb: 179 + 15 = 194 lb abs.

Then, turning to the steam tables, you find that the "total heat" of one pound of steam at 194 lb abs temperature and 520 F is 1280.4 Btu.

If the feedwater temperature is 208




**Difference in enthalpy between feedwater and steam equals the heat required to convert the feedwater into steam**

F, its "heat content," above water at 32 F, is merely 208 − 32 = 176 Btu. Therefore, the heat *put into* each pound by the boiler is 1280.4 − 176.0 = 1104.4 Btu. Heat put into 9.4 lb will be 10,381 Btu.

Then, boiler efficiency = Output ÷ Input = Heat put into 9.4 lb steam ÷ Heat in 1 lb of coal = 10,381 Btu ÷ 13,260 Btu = 0.783 = 78.3%.

If you plan to make many boiler-efficiency computations you will need a book of steam tables. The latest tables, now generally accepted as standard in this country, are titled "Thermodynamic Properties of Steam" by Keenan and Keyes. They are published by John Wiley & Sons, New York.

A word about the use of this book. If you want data on liquid water at any temperature, use Table 1. For data on steam at saturation temperature (boiling point), use Table 1 if you know the temperature and Table 2 if you know the pressure. All pressures in these tables are absolute. To get absolute pressure, add 14.7 lb to the gage pressure (15 lb is close enough for usual range of boiler pressures).

For the properties of superheated steam, as in the problem just figured, use Table 3. This superheated-steam table must be entered with the absolute pressure (gage pressure plus 15), and with the *total* steam temperature, not the degrees of superheat. This total temperature is the saturation temperature (also given in the table) plus the degrees of superheat.

### *"Enthalpy"*

In this elementary article I have talked about the heat "in the water" and the heat "in the steam," because these expressions are old and familiar to most practical engineers. It is necessary to point out, however, that these expressions are now in bad repute in scientific circles.

What I have called "heat in the steam" is now termed the "enthalpy" of the vapor. What I have called "heat in the water" is now termed the "enthalpy" of the saturated liquid.

Thus, using the modern Keenan and Keyes tables for the given problem, you would proceed as follows:

| | |
|---|---|
| Table 3— | |
| Enthalpy of superheated vapor at 194 lb absolute and 520 F..... | 1280.4 |
| Table 1— | |
| Enthalpy of saturated liquid at 208 F..... | 176.0 |
| Difference..... | 1104.4 Btu |

As before, the 1104.4 Btu is the heat required to make one pound of steam from the given feedwater.

# ARGUMENT CORNER

## Neatest Trick of the Month

I WOULD LIKE to comment on the article appearing in July POWER under the above title. The difficulties with leaking oil tank heaters do not constitute a problem I have ever encountered, but the solution described seems kind of round-about to me.

If the water works in your community is of any size, it will have as part of its equipment a Mueller or Smith tapping machine used to tap water mains under pressure. The special valves have ears to hold the tapping machine at one end and either sleeve adapters or flanged fittings at the other end.

If the problem stated should present itself to me I would wire out two 6-in. flanged valves for the tapping machine (it might be necessary to rent the tapping machine from a nearby town), procure two welding neck flanges and go to work. First, weld the two flanges to the tank exterior (the spacing in a vertical line to be determined by the convection head required for best circulation), attach the tapping valves to the flanges which are now mounted on the tank, next make two conventional tapping operations.

We now have two 6-in. connections to the tank, and the heater can be constructed with 6-in. connections at top and bottom. Then connect to the two valves, make up suitable auxiliary piping and we are all set to go.

*Hibbing, Minn.* A L BENNETT

## Slip of the Pen

EVEN EDITORS know the difference between a compound steam engine and a single-cylinder engine. Yet this statement appeared in "How to Indicate a Steam Engine," page 109, August POWER: "The engine illustrated here . . . so that both *high-* and *low-pressure ends* of the cylinder may be indicated from one position."

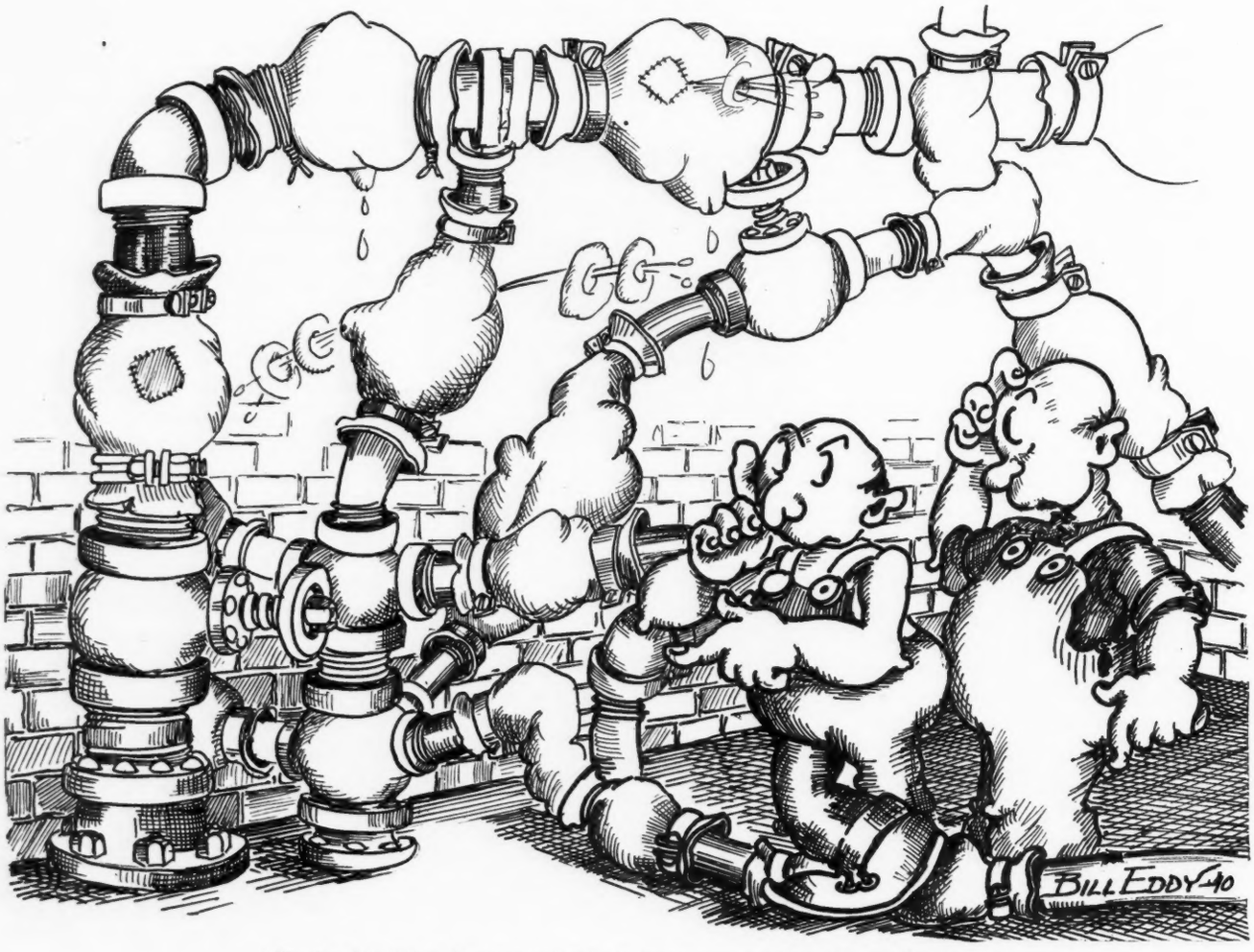
Obviously, "head and crank ends" was intended to come out of our pen.

## Glorious Is the Word

ABOUT BOILERS—Scotch, Yankee and Cornish (referred to by Mr Gorrie, of Scotsman's Goat fame). They are all tanks and limited as to pressure and size. To this extent they are comparable.

Glorious? It's a good word! No place on earth, except these United States, could a Caledonian and a Hibernian call each other names and expect to be paid for it. In the interests of fair play and to give the editors a breathing spell, I'm saying "Uncle".

*Arlington, Va.* W H MCKINNEY




**"Maybe this 'Plant Expansion' talk is just a rumor after all, eh Murdoch"**

# SHORT QUESTIONS — QUICK ANSWERS

## *Boiler-Room Accessories*

*Q—What is the difference between an open heater and a closed heater?*

A—An open heater warms feedwater by direct contact of steam and water at low pressures. Clean steam must be used, and the heater is on the suction side of the feed pump. In a closed heater, tubes separate steam and water.

---

*Q—Explain the use of breeching.*

A—A breeching is a sheet metal duct that conducts flue gas from a boiler setting to the base of the stack.

---

*Q—What is a dead plate?*

A—A cast-iron plate used to floor the firing-door opening of hand-fired and some stoker-fired boilers. Green coal is fired on this plate so that its moisture and volatiles can be partially driven off before it is pushed back onto the grates.

---

*Q—What is meant by the following terms as referred to superheaters: (a) convection, (b) radiant?*

A—(a) A convection superheater is away from the direct light of the fire, and receives its heat by direct contact with the flow of hot gases. (b) A radiant superheater is in the direct light of the fire and receives its heat by radiation in this manner.

---

*Q—How does an economizer differ in principle from a feedwater heater?*

A—The economizer utilizes waste heat in flue gases as a heating medium while the feedwater heater uses steam.

---

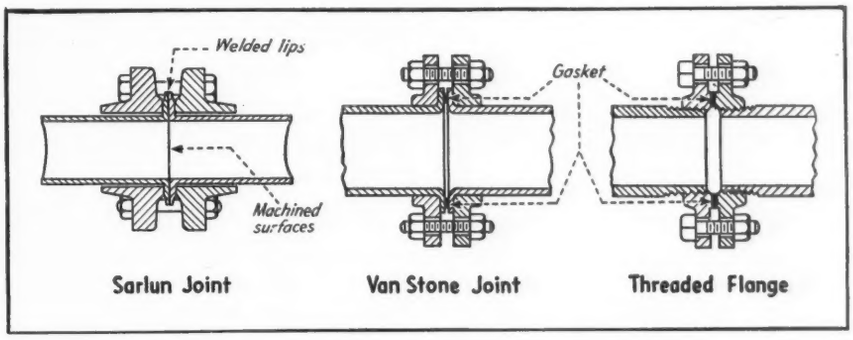
*Q—What is an air preheater and how does it differ from an economizer?*

A—An air preheater is a device for preheating air for combustion service, and uses the waste heat in flue gas as a heating medium. The economizer, though using the same heating medium, heats feedwater, not combustion air.

---

*Q—What materials are commonly used for condenser tubes and what are the requirements of such tubes?*

A—Admiralty metal and several special copper base alloys containing such elements as aluminum and nickel. The controlling requirement is resistance to corrosion.




*Q—Referring to surface-condenser operation, what is meant by terminal difference and by heat-transfer coefficient?*

A—Terminal difference is the difference between the final temperature of the cooling water and the temperature corresponding to the observed vacuum, and is due to air in the system and to inefficiency of heat transfer. Heat-transfer coefficient is actually the heat units transmitted from the steam through the tubes to the cooling water, expressed in Btu's per sq ft of cooling surface, per hr, per deg difference between steam temperature and mean temperature of the cooling water.

---

*Q—Name two methods of taking care of expansion in pipelines?*

A—Expansion loops formed by bending the pipe, and slip-type or bellows-type expansion joints.

---

*Q—What materials are used for gaskets in pipelines and for what field is each most suitable?*

A—Rubber for hot and cold water, and saturated steam at low to moderate pressure. Asbestos for superheated steam, dry air, gases, ammonia and oil. Metallic (lead, soft iron, copper) for special services, lead for acids, copper for superheated steam of moderate temperature and soft iron for high-temperature service. Canvas gaskets are used for water pressures up to about 125 lb per sq in.

---

*Q—What is meant by pH of boiler water?*

A—Mathematically, pH is the log of 1 ÷ the hydrogen-ion concentration, used to express acidity or alkalinity. A pH value of 7 is neutral. If the hydrogen-ion concentration of a boiler water is $10^{-6}$, the water is acid and is said to have a pH of 6. If the hydrogen-ion concentration is $10^{-11}$, the water is alkaline with a pH of 11.

---

*Q—Why do some pumps have flywheels and for what service is this type used?*

A—When steam is worked expansively in the steam cylinder driving the pump, rather than admitting steam for the full stroke, the flywheel is necessary to carry the piston over dead center and to give comparatively uniform motion throughout the stroke. This type of pump is used for service in large water works, hydraulic elevator systems, and for pumping molasses in sugar mills.

---

*Q—Why is it important that air and other non-condensable vapors be removed from the condenser?*

A—Because they are poor conductors of heat and they decrease the degree of vacuum obtainable.

---

*Q—What are the sources of the gases named above?*

A—Air leakage due to the pressure differential between atmospheric pressure and the vacuum system, as at gaskets, glands, casting defects, etc. A certain amount of free oxygen, $CO_2$, hydrogen, and other non-condensable gases may enter with the steam flow from the boilers.

---

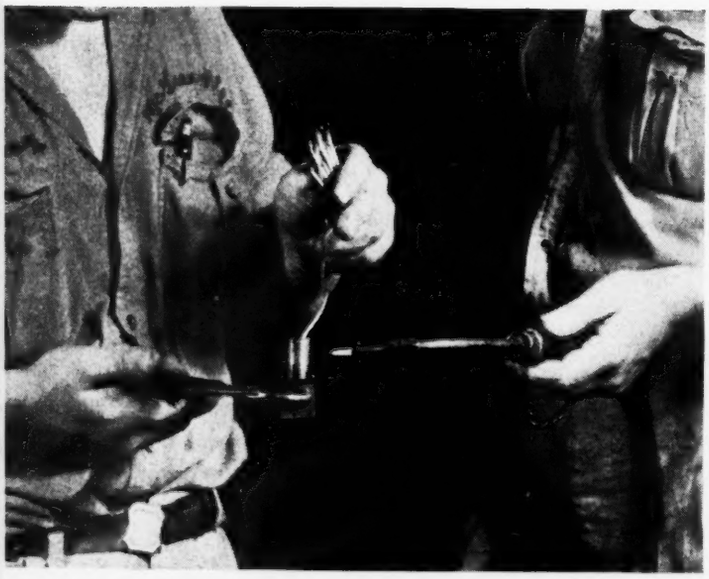
*Q—Sketch and name three forms of pipe flanges.*

A—Sarlun, Van Stone and threaded flange, see illustration above.

# HOW TO SOLDER CABLE LUGS

▶ SOLDERING LUGS onto electric cables is not a difficult job if you follow this simple rule: See that surfaces to be soldered are clean, properly tinned and at the correct temperature. The latter is very important; if surfaces are too hot or too cold you will get a poor joint. Lug and wire should be just hot enough to cause the solder to flow freely.

**1** **Cut insulation square and bare the wire for a length equal to the lug socket plus ½ in. Clean the wire thoroughly and apply soldering flux**

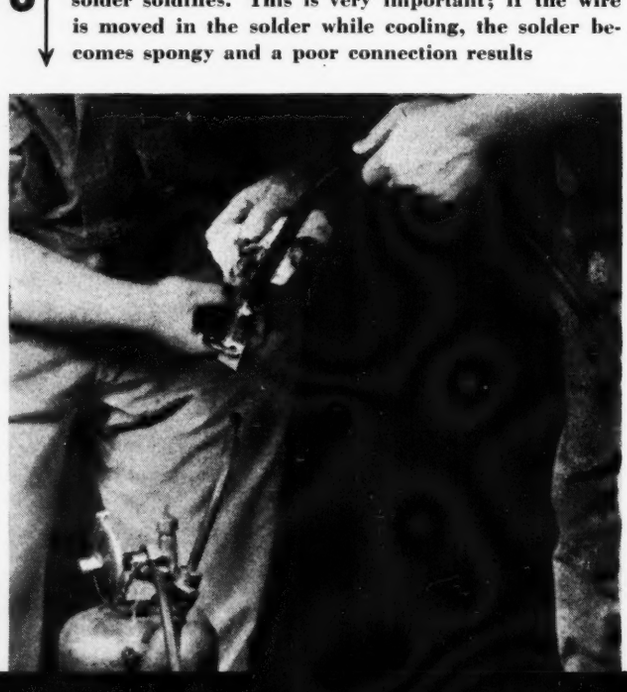


**2** **Heat the lug and partly fill it with solder and flux. Stir the solder in the socket until its inside surface is well tinned**

**3** **Empty solder and flux from the socket and partly refill with fresh solder. Put end of wire into the solder and let it remain while applying heat to the lug. Keep heat on until the wire has been brought to soldering temperature and is tinned. Remove wire from socket and wipe off excess solder to make sure that the wire is properly tinned**

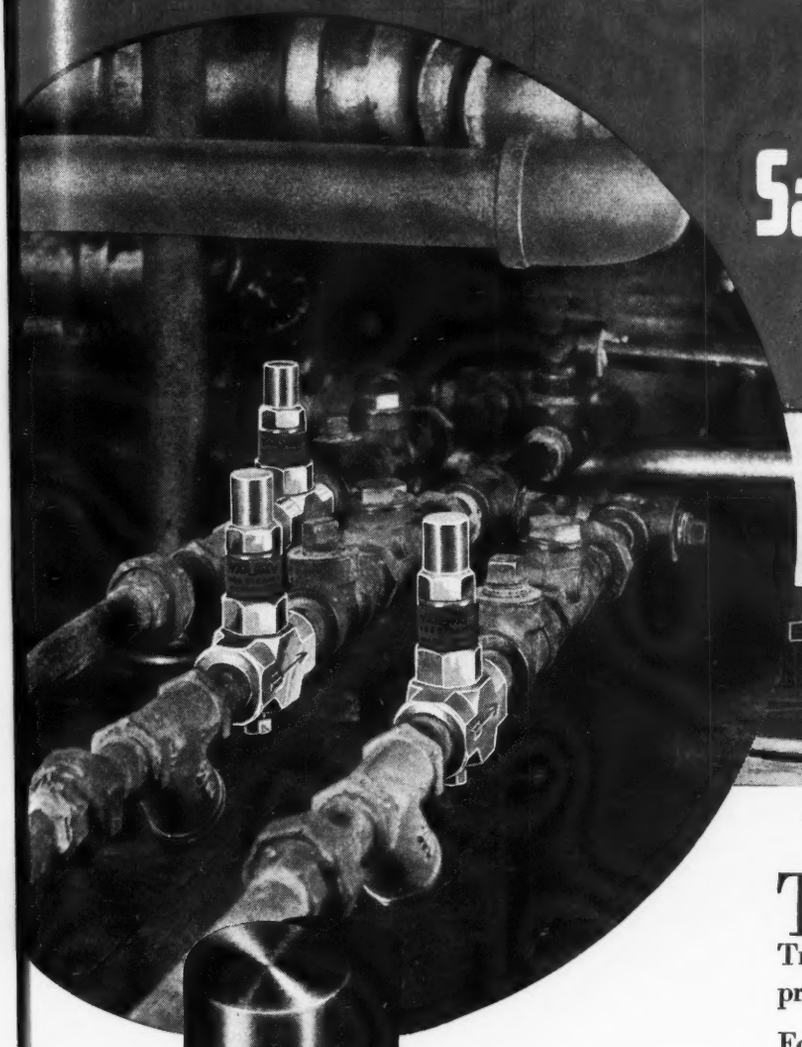
**4** **Put end of the wire all the way down into the lug socket, heat the terminal and fill socket with solder**

**5** **Remove heat and hold terminal and wire still until solder soldifies. This is very important; if the wire is moved in the solder while cooling, the solder becomes spongy and a poor connection results**



# Individual Trapping with YARWAYS Speeds Heating-up Saves Shut-Down Time

## for Eagle Dye Works, Hartford, Conn.



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## YARWAY IMPULSE STEAM TRAP

# Smooth Speed Control of Wound-Rotor Motors

By H E LARSON
*Industrial Department, General Electric Co*

***With special reactors, speed of wound-rotor motors can now be regulated from zero to 85% synchronous with a torque range of from 15 to more than 100% for a given speed***

▶ SATURABLE-CORE REACTORS are now being used to control speed and torque of wound-rotor induction motors. These drives provide adjustable-varying speeds over wide ranges in a smooth stepless manner compared to coarse-stepped control by rotor resistance using bulky drum controllers or magnetic contactors.

Such a drive consists of a conventional wound-rotor induction motor with a saturable reactor in series with the stator windings and a small amount of permanent resistance connected in series with the rotor windings, Fig. 1. Speed or torque of such a drive is controlled by adjusting reactor saturation.

A saturable-core reactor differs principally from the conventional iron-core reactor (with a single winding on an iron core) in that it has a saturating winding excited from a direct-current supply, in addition to the usual main alternating-current winding connected in series with the stator windings of the motor, Fig. 1. These two reactor windings are arranged non-inductively with respect to each other so that no ac voltage is induced in the dc winding. By increasing the dc exciting current in the saturating winding, the reactance of the ac winding can be varied through a wide range such as 10 to 1 or even 15 to 1. In this manner, voltage applied to the induction motor is varied to produce a smooth change in motor torque and speed.

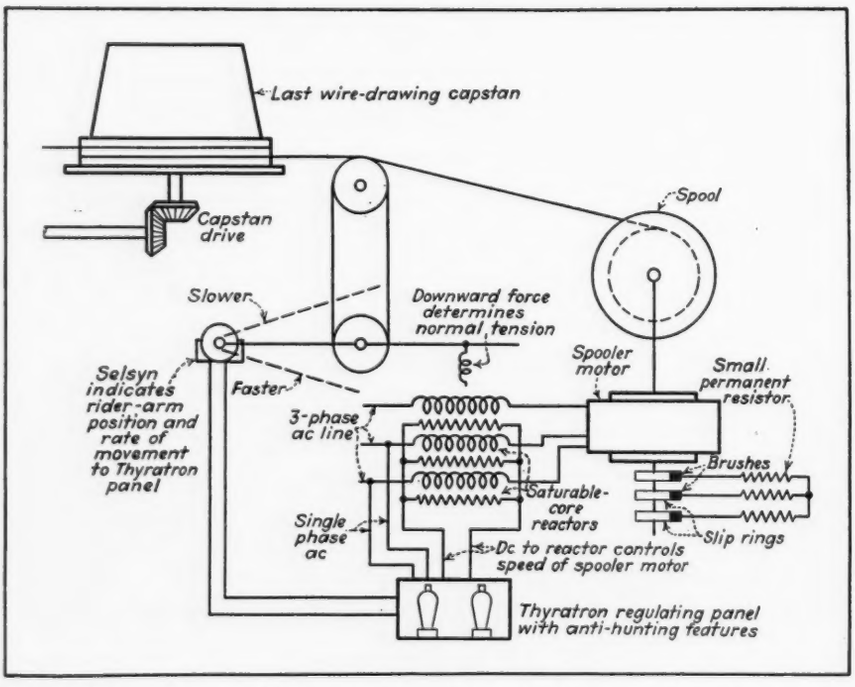


**Fig. 1—Automatic saturable-core-reactor control maintains constant tension in wire between wire-drawing machine and spooler**

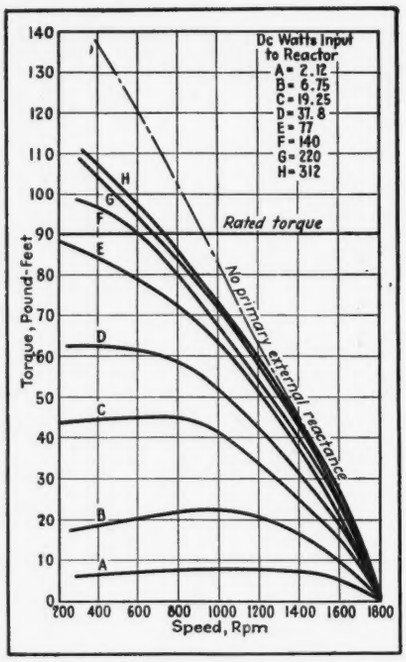


**Fig. 2—Speed-torque curves for a 30 hp, 1800-rpm, wound-rotor, induction motor with 0.92-ohm external rotor resistance under saturable-core-reactor control**

While no ac drive can equal the flexibility and other qualities of dc equipment, the system described gives smooth stepless control of accelerating torque, running torque or speed, decelerating or plugging torque. It has a speed range from standstill to approximately 85% of synchronous speed, for 100% rated motor torque. The torque range is from 15 to more than 100% for a given speed.

### *Automatic Regulation*

Automatic regulation is obtained more easily and with less expense than with rotor-resistance control. Starting control is greatly simplified, eliminating secondary accelerating contactors. Even timing relays for controlling the reactor excitation circuit during starting can be omitted by designing exciting circuits with high time constants. Improved efficiency is obtained compared with rotor-resistance control. Cost of motor, reactors, and control is usually less than that of other types of adjustable-varying-speed drives which use constant-speed ac motors with variable-speed equipment.

A typical 3-phase, wound-rotor, induction motor control using saturable-core reactors will include three single-phase reactors, a permanent resistance for the secondary circuit, a primary line contactor, thermal overload relays, a slide-wire rheostat for manual control,

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# Smooth Speed Control of Wound-Rotor Motors (Continued from page 118)

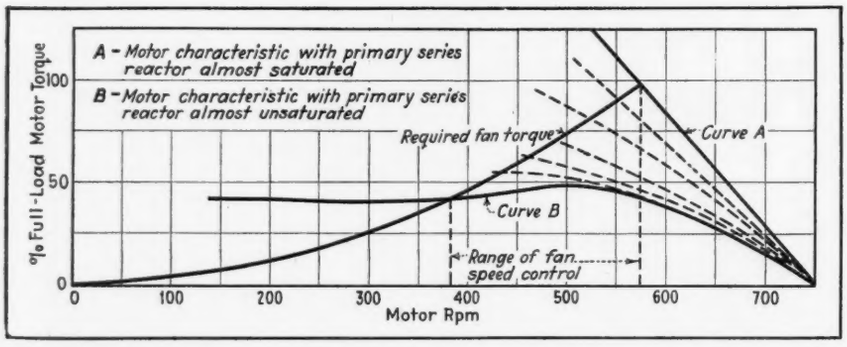



**Fig. 3—Speed-torque curves of a 200-hp, 750-rpm, wound-rotor motor, under saturable-core-reactor control, driving an induced-draft fan**

or an automatic means for adjusting the dc excitation. Independent control of accelerating and plugging torques can be obtained by using separate rheostats for the dc saturating winding with small transfer relays.

Typical speed-torque characteristics are shown in Fig. 2. The shapes of these curves can be controlled to suit load requirements by proper selection of permanent secondary resistance. Fig. 3 shows speed-torque curves of one of these drives for meeting the requirements of an induced-draft fan.

It should be understood that saturable-core-reactor control alone does not change the inherent adjustable-varying-speed characteristic of a wound-rotor motor. When operating at reduced speed, whether with rotor resistance or with reactor control, variations in load torque will cause changes in speed. These drives are, therefore, not comparable with adjustable-speed dc drives having shunt characteristics.

Adjustable speed with shunt characteristics can be obtained, however, by supplementing saturable-core-reactor control with a counter-electromotive-force exciter or speed regulator. This will hold the speed of the drive to any given preset value with reasonable regulation within a definite range, regardless of load torque.

The amount of dc power required for the saturable-core-reactor is small, ranging, for example, from zero to 312 watts for the entire speed and torque range of a 30-hp motor, Fig. 2. Copper-oxide rectifiers can be used for supplying excitation requirements when dc is not available.

Since saturable-core-reactor control costs more than conventional rotor-resistance control, it is not intended to supplant the latter in all cases. A few of many typical applications where saturable-core reactor control should be considered when ac drives must be used are main drives of wire-drawing machines, spooler drives of wire-drawing machines, Fig. 1, tension-reels of rolling mills, fans and pumps.

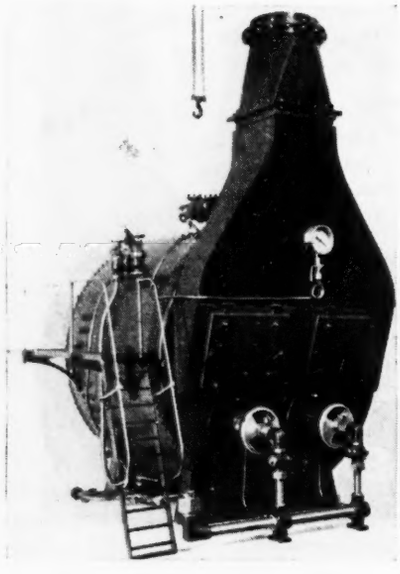
### *Applications*

One important general field of application is that requiring automatic-speed or torque control. In such instances, the dc input to the reactors may be easily regulated by phototubes, thyratrons, Amplidyne exciters, Selsyn transmitters with rectifiers, or other means capable of delivering dc power in small quantities in response to the commands of a regulatory system.

Some constant-speed applications, such as main drives of wire-drawing machines, require only smooth starting and accelerating characteristics from rest to approximately 80% of final running speed. Accelerating from 80% of running speed to full speed can be had without objectionable effects by short-circuting all the rotor external resistance. This may be done by one accelerating contactor closing after full exciting current of the reactors has been reached. In this way, the constant-speed running losses of the drive are reduced to little more than those in a conventional wound-rotor motor with its slip rings short circuited.

✦ ✦ ✦

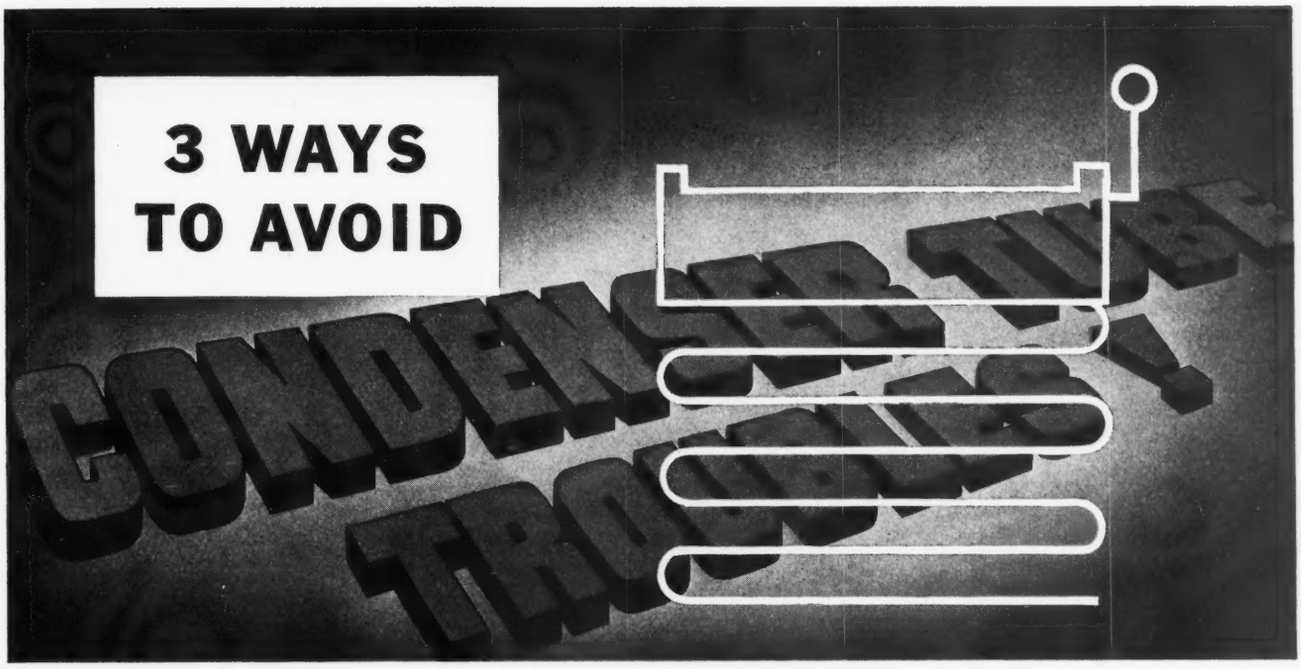
# Model Maker's Problem



**Model boiler works fine except that gage glass acts as capillary tube, doesn't show correct water level**

►Fred Hood, master model maker, (1928 Cordova Street, Los Angeles, Calf.) has a problem. His scale-model Scotch-marine boiler (described on pages 84 and 85, November, 1938, Power) is now finished and perfect except that the gage glass (3/32-in. inside diameter) won't show the correct water level because af capillary action. He is thinking of using a flat-glass gage of the "Klinger" type. If you have any suggestions or sketches send them directly to Mr Hood.

When he was in Los Angeles last summer, Editor Swain visited Fred Hood to inspect this boiler, minus fittings, and a scale model of a triple-expansion marine engine. Both are actual working equipment, machined to scale in every detail, and both are superlative examples of fine craftsmanship.

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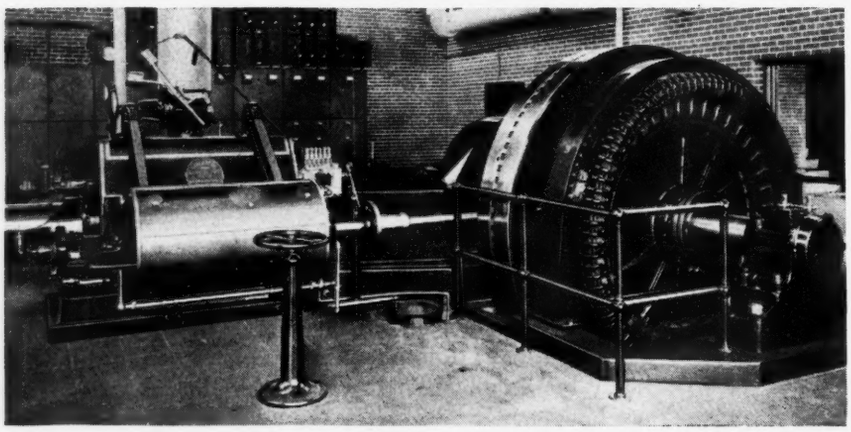
# How to Lubricate Cylinders on Wet Steam

***William G Forbes, lubricating engineer, Tidewater Associated Oil Co, tells what's desired in an oil for exacting services. Suggestions given as to viscosity, etc, for various lubricants***



**Steam-engine-cylinder lubrication difficulties are not all chargeable to the oil, but can be frequently traced to mechanical faults in the working parts of the engine**

► PROPER STEAM-ENGINE cylinder and valve lubrication is a matter of common-sense diagnosis; the rules are logical and not difficult to follow. Lubrication problems fall into two classes: (1) for engines operating with wet steam and (2) where the steam is superheated when it leaves the boiler. As a majority of engines operate on wet steam, we will confine our attention to class 1.

It is a logical assumption that all steam without superheat leaving a boiler will contain free water when it gets to the engine throttle. Under average conditions saturated steam generated at 175 lb or less will contain 3 to 10% moisture when it reaches the engine throttle valve. Saturated steam leaving the boiler at 175 lb or over will have 2 to 5% moisture when it reaches the engine throttle. When engines are far from the boilers and steam lines are not properly insulated the moisture content may be even higher.

Engine-room practice requires that one oil satisfy all the steam conditions existing on cylinder walls and valve faces. Within an engine factors having the greatest influence on steam conditions are load, cutoff, cylinder size and piston speed. When large non-condensing engines of more than 24-in. stroke operate continuously partially loaded, effect of condensation on cylinder walls and valve is generally pronounced. Early cutoff has a similar effect.

Under such conditions, use a light-body cylinder oil (100 to 130 sec Saybolt viscosity at 210 F for best results. Such a lubricant will distribute readily over the cylinder and valve surfaces and if 10 to 14% compounding is used it provides a strong emulsion that will adhere to the wet surfaces.

### *Compounded Oil*

This oil offers maximum resistance to being washed away by moisture and will therefore give adequate lubrication with a low rate of oil feed. If throttle-valve pressure is under 100 lb, it will sometimes be advantageous to use a compound of tallow oil and degras. The degras will increase the strength of the emulsion, but for pressures much above 100 lb it may tend to decompose under the higher steam temperatures.

Large non-condensing engines operating continuously at full load, supplied with wet steam at the throttle valve, are seldom difficult to lubricate. Steam velocities are sufficiently high to atomize the oil thoroughly and condensation is not generally excessive. It is advisable, however, to use as light a cylinder oil as possible in order to obtain rapid spreading over the large area of the internal moving parts.

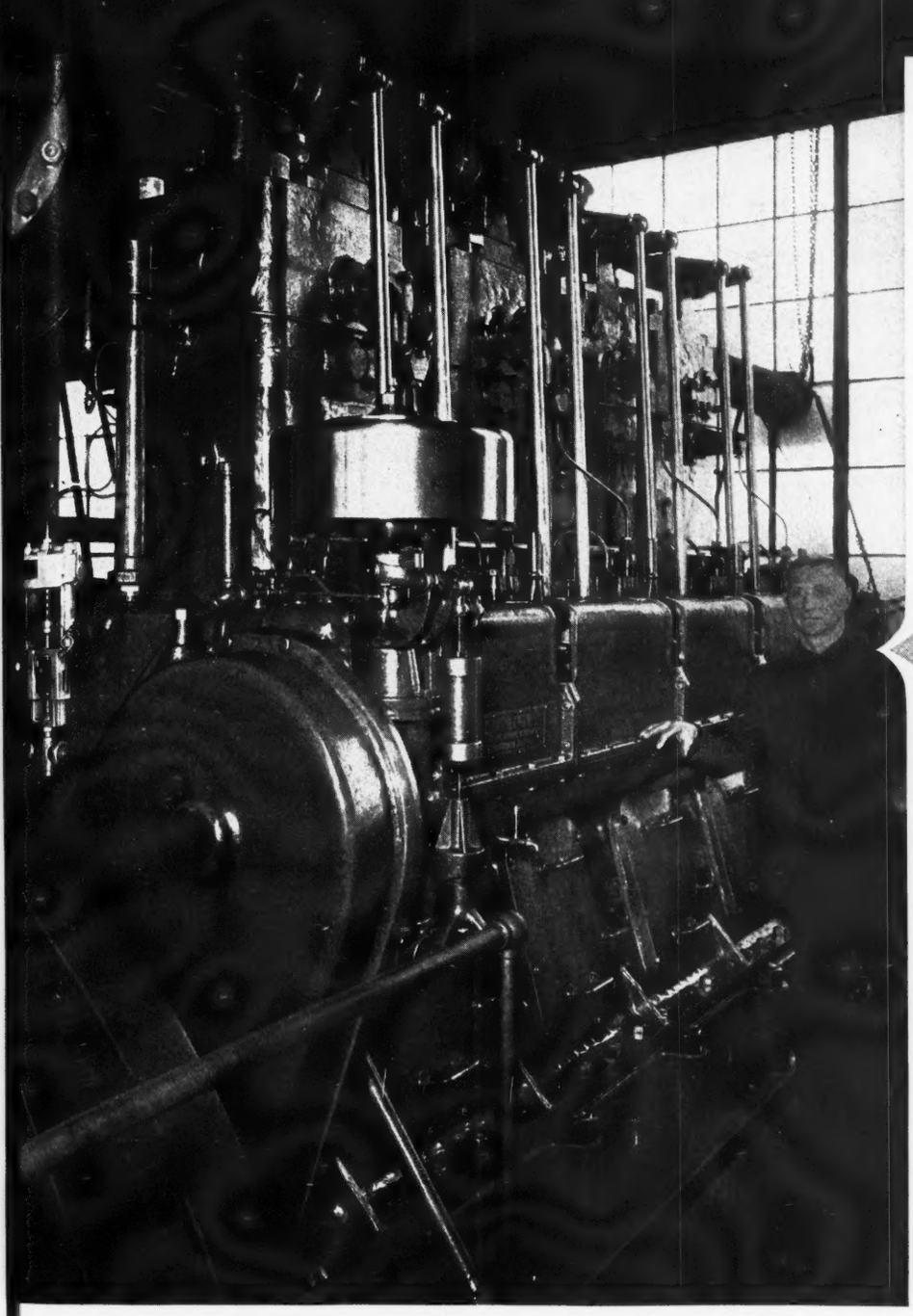
Generally, the cylinder oil should have an approximate Saybolt viscosity of 110 to 130 sec at 210 F and 8 to 12% of compounding for pressures below 175 lb g; for pressures above 175 lb g, conditions should be 130 to 160 sec viscosity at 210 F and 6 to 10% of tallow oil. The higher the pressure the heavier the oil used and, as a general rule, the less compounding required to maintain satisfactory emulsion.

For example, under normal conditions, steam generated at 200 lb g will not contain much moisture at the throttle valve. The pressure may show a slight drop but the moisture content will probably be about 3%. Hence, with ample steam velocity to break up the oil and a temperature of approximately 380 F, a cylinder oil having a viscosity of 140 to 150 sec at 210 F and 6 to 8% of tallow oil should be about right.

### *Multi-Cylinder Engines*

Multi-cylinder engines are not generally considered as separate problems in lubrication. If the cylinder oil is properly selected for the high-pressure cylinder it will be thoroughly atomized, thinned and mixed with the steam when it reaches the succeeding cylinders. Occasionally, it may be found advantageous to compromise by favoring the low-pressure cylinder or cylinders with a lighter-bodied oil and more compounding than considered correct for the high-pressure cylinder. Steam pressure behind the piston rings presses them against the cylinder walls. This effect is more pronounced in the high-pressure cylinder than in the low-pressure. Hence, any compromise must not be to an oil too light in body when favoring the low-pressure cylinders.

Many engineers believe that horizontal engines require heavier-bodied oils because the weight of the piston is



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# How to Lubricate Cylinders on Wet Steam

(Continued from page 122)

supported by the rings resting on the lower half of the cylinder. This theory is not particularly sound. The heavy-bodied oils do not spread as quickly in the presence of wet steam and their theoretical advantage is somewhat nullified.

Lubrication of engines less than 24-in. stroke using wet steam are not very different to those of larger sizes. The smaller engines generally operate at higher speeds. When exhausting to atmosphere, cylinder-lubrication becomes a matter of how much compounding should be in the oil and the approximate body required for the steam pressure. When special cylinder-lubrication problems arise with small engines, they are generally due to long steam lines or unusual conditions resulting in excessive steam-moisture. For wet steam in engines exhausting to atmosphere and steam pressures below 175 lb g at the throttle valve, the cylinder oil should have a Saybolt viscosity of 100 to 130 sec at 210 F with 6 to 10% of compounding. Above 175 lb g at the throttle valve, Saybolt viscosity should be 130 to 150 sec at 210 F with 6 to 10% of tallow oil.

An excess of compounding, above that required for the moisture conditions, will not improve the emulsifying properties of a cylinder oil. However, it is only with superheated steam that excessive compounding assumes importance, because high temperatures tend to decompose tallow oil. On the other hand, for wet-steam operation, quality of the cylinder oil is often important in securing a good spreading effect over valve and cylinder-wall surfaces. Filtered cylinder stocks and bright stocks atomize easily and generally give superior results to those obtained with the average grade of steam-refined stock. Improvement in lubrication can often be secured by checking on this detail, particularly on large engines where considerable surface area must be covered by the oil.

Engines operating on wet steam and exhausting into a condenser or heating system present a lubrication problem, particularly when the condensate is returned to the boilers or used for process work. Here, separation of the oil from the steam or water is necessary and it is generally safest to use a straight mineral oil. Emulsions produced by a compounded oil cannot be broken by the usual types of commercial filter employed in engine rooms. Use a bright-stock steam-cylinder oil because this grade not only atomizes and spreads readily but has excellent separating qualities.

It is often difficult to lubricate steam-engine cylinders effectively with straight mineral oils, particularly when the steam is wet at the engine throttle. Feed rate has to be liberal to compensate for the washing effect of moisture in the steam. Under some conditions the amount of oil required for satisfactory results may tend to be excessive and therefore impractical. Then it is advisable to try a bright stock containing 3% of tallow oil.

### *Filter Condensate*

Filter the condensate at the lowest possible temperature to assist separation and carefully check the filtered condensate to determine the oil content. This should be done by a qualified chemist who knows proper boiler-feedwater requirements. With an efficient filter and careful maintenance of the filter material, a bright-stock with 3% tallow oil is often practical to use and is the solution to a troublesome cylinder-lubrication problem.

Suitable oil for piston-rod swabbing is important on engines where the condensate is returned to the boilers. If condensate is filtered, use a straight mineral oil. If condensate it not filtered, use a compounded oil to obtain an adhesive lubricating emulsion. This choice will reduce the amount of oil required for proper lubrication and will therefore cut down the amount in the condensate.

Mechanical condition of the piston rings plays an important part in cylinder lubrication. If they are worn and leaky, the continuous blowby will make it difficult to maintain an oil film. Chamfer the sharp edges of the piston rings, as in Fig. 1, to prevent them from acting as scrapers, Fig. 2.

Cylinder-lubrication troubles are not always caused by the oil. Methods of supplying the oil are important and require a careful check, particularly when an excessive amount of oil is needed to maintain an adequate film on the rubbing surfaces. Perhaps the oil atomizer is not in the best place in the steam line or an additional lead to the cylinder may be required. All these points are important and have a bearing on the final result.

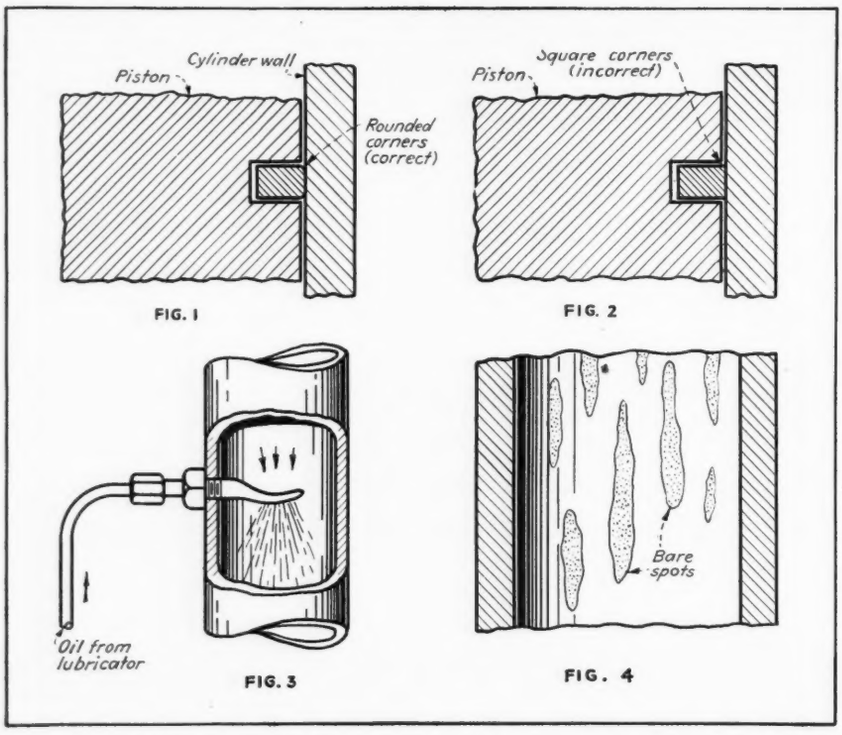



**Fig. 1—Rounded corners of piston rings assist in proper lubrication. Fig. 2—Sharp corners on rings scrape oil from cylinder walls. Fig. 3—Make atomizer in steam line spoon-shape to prevent oil being blown from it. Fig. 4—Oil with insufficient compounding will be washed from the cylinder by moisture and leave bare spots**

# Water Velocity?
# Condenser Design?
# Temperature?
# Water Conditions?
# Presence of Air?

## Which condenser tube alloy is best for *your* combination of these variables?

THERE is such a complication of operating factors having an influence on the service life of condenser tubes that no one tube alloy can possibly solve all problems.

To determine the tube alloy that will give the greatest service per dollar of cost requires metallurgical experience and practical knowledge of specific operating conditions. So we suggest that you take advantage of the experience of our Technical and Engineering Departments. They can place before you performance records of copper alloys under operating conditions similar to your problem. No charge is made for such consultation. 40111

**ANACONDA TUBE SHEETS**—We produce a complete line of plates and circles for marine and stationary condensers, heat exchangers, feed water heaters and oil coolers. The same careful technical supervision used to control the manufacture of Anaconda Condenser Tubes is given this material during the entire process of production.

ANACONDA
from mine to consumer

## Anaconda Condenser Tubes

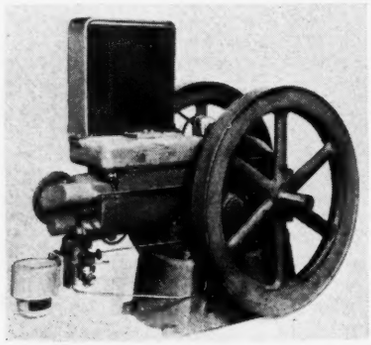
THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

*In Canada: Anaconda American Brass Ltd., New Toronto, Ont.* • *Subsidiary of Anaconda Copper Mining Company*

# WHAT'S NEW IN PLANT EQUIPMENT

## Gas Engines

SINGLE-CYLINDER, slow-speed, type Z engines available in four sizes with cylinder displacements of 118, 208, 346, and 503 cubic in. New line incorporates several features, among them vapor-phase cooling, renewable valve seats, oil-impregnated, bronze-bushed valve guides, roller bearings, controlled-splash lubrication, and inter-



nally-mounted governor operating in oil bath. In vapor-phase cooling system, condensing radiator is mounted directly on top of cylinder. Steam generated from water expands into special chamber and enters radiator. Air forced through radiator by cooling fan condenses this steam to water which is returned to the system. Thus temperature of engine is held constant regardless of load or outside temperature, without use of thermostats or radiator covers. Engine is available in combinations with electric generators, pumps, compressors, etc.

*Fairbanks, Morse & Co, 600 S Michigan Ave, Chicago, Ill.*

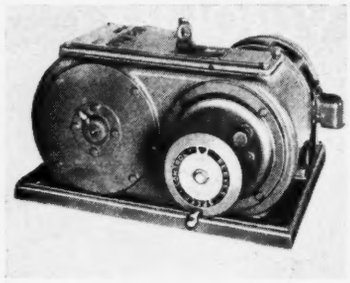
## Fluorescent Lamp Diffuser

P F C PLASTIC diffuser snaps on over bare fluorescent lamps. Available for 1- and 1½-in. lamps, in 5 colors: white, light blue, yellow, pink and pale green. Plastic construction makes diffuser shatterproof, according to manufacturer.

*Edwin F Guth Co, 2615 Washington Blvd, St. Louis, Mo.*

## Speed Indicator

"SPEEDIAL" is improved type of handwheel-speed indicator for use with Reeves transmissions. Said to indicate accurately speed settings of different units. Actual indication is definite number of turns of speed-shifting screw of unit. For each full turn of shifting screw, Speedial, with indicator attached, registers one point, or degree, on circular scale, as shown in photo. Unit is offered as optional equipment at extra cost in place of standard speed-control handwheel and indicator on various Reeves drives. While standard unit is calibrated in turns of the shifting screw, space is available on dial for user to write



his own calibrations in whatever corresponding units he prefers. Blank dials can also be calibrated to user's individual requirements.

*Reeves Pulley Co, Columbus, Ind.*

## Packing

ADDITION to line is Palmetto compressed sheet packing, made of long fibre asbestos combined with bonding agents, and produced in uniform thicknesses. This is an all-purpose flange and joint packing for superheated and saturated steam at high pressures and temperatures, for air, ammonia, gases, oils, gasoline and most chemical solutions.

*Greene, Tweed & Co, 101 Park Ave, New York, N. Y.*

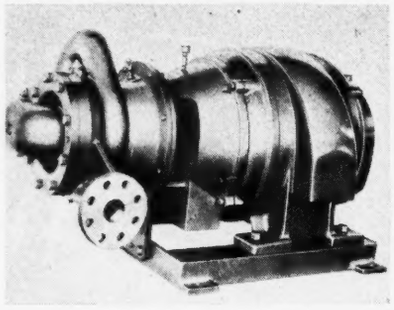
## Pressure Pads

RESILIENT pressure pads for holder-end of brushes made to offset injurious effects of vibration on carbon brushes and are secured to holder end at point of contact with pressure finger. Within normal range of temperatures, pad will retain its resiliency throughout life of brush. Form of pad and exact location on brush dependent on shape and dimensions of pressure finger, location of contact with brush.

*National Carbon Co, Inc, Cleveland.*

## Unit Pumps

"SSUNIT" pumps, in which motor and pump housing are bolted together for compactness, have had additions made to line. New pumps have cast-iron casing and cover, similar to other pumps in line, and are bronze fitted throughout. Impellers are placed back-to-back to provide axial balance. Cover can be taken off, permit-



ting inside parts to be removed without disconnecting suction and discharge piping. Stuffing box on pump is only part subjected to suction pressure, according to pump maker. Unit can be furnished with either open, splash-proof, totally-enclosed or explosion-proof motor.

*Allis-Chalmers Mfg Co, Milwaukee, Wis.*

## Inhibitor

ORGANIC CHROMIUM inhibitor is used in small quantities. Experimentally applied in both liquid and vapor phases this chemical is said to control both oxidation and sulphide types of corrosion. Quachrom Glucosate, as inhibitor is called, forms an oxidation film which protects metal surfaces from corrosive attack. Film is resistant and self-repairing, offering a maximum protection from corrosion with a minimum of control, according to manufacturer.

*D W Haering & Co, 2308 S Winchester Ave, Chicago, Ill.*

## Floor Resurfacer

IMPROVEMENT in Ruggedwear Resurfacer is "Chrysotile", a fibrous rock resistant to all ordinary acids, with twice the strength of regular asbestos fibres, waterproof, and claimed not to rot or disintegrate. Improvement said not only to produce tougher wearing characteristics but also tougher and finer feather edge for finishing.

*Flexrock Co, 23rd & Manning Sts, Philadelphia, Pa.*

## Stoker Control Relay

SINGLE-POLE relay combines low-voltage control transformer, relay and terminal board, for controlling stokers in conjunction with time switch, limit control and

# The Case of the BURNED BEEF STEW

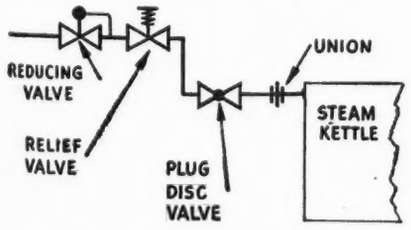
**SOLVED WITH PREVENTIVE MAINTENANCE**

HERE'S how the chef in a mid-western hospital discovered something about valves that is significant to any plant with extensive piping. The chef raised the lid of a steam kettle ready to dish up a savory beef stew.

Instead, he found a badly scorched mess.

By his clock he knew that it had not cooked too long—the heat should have been constant—but something had happened—something beyond his control.

The engineer of the hospital diagnosed the trouble thus: "Pressure regulator's gone blooey," he stated. "Look at the sediment in this reducing valve. If you had that much junk inside of you, you would fail, too."




When W. F. C., the Crane Representative, appeared in response to a telephone call, he quickly found the answer. Obviously, simply cleaning the regulator was asking for more trouble later—Preventive Maintenance dictated some form of protection for the kettle to prevent extreme temperature from ruining more food.

The answer was simple—see the hookup at left. A Crane relief valve, placed on the low pressure side of the pressure reducing valve, gave assurance that in the future, failure of the pressure regulator would not result in further disaster to beef stews.

**RESULTS: (1) No more danger of uncontrolled steam under high pressure reaching the cooking kettles. (2) One more user of valves and fittings has learned that Preventive Maintenance prevents further trouble from valves by recommending the correct valve of the correct materials in the correct hookup. (3) Another valve user has found that he can be assured sound advice on piping problems by calling the Crane Representative.**

*This case is based on an actual experience of a Crane Representative in our Kansas City Branch*

## YOUR PLANT IS SAFER WITH CRANE RELIEF VALVES

• You may never have occasion to worry over scorching a beef stew, but in your plant—in fact, in almost every plant—the judicious application of relief valves on pipe lines will prevent many maintenance problems from becoming serious—save many dollars in time lost or material destroyed, as well.

Crane relief valves are made in brass, iron and steel—designed to control air, gas, water or steam. Available in sizes from ⅜″ to 5″ to meet every requirement where a relief valve may be necessary.

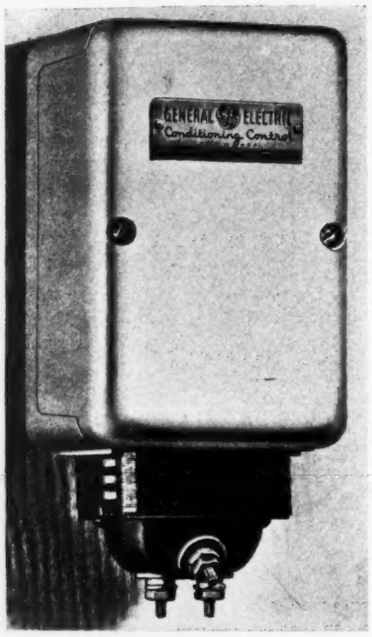
1940 our 85th YEAR

# CRANE

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVE., CHICAGO

*VALVES • FITTINGS • PIPE*
*PLUMBING • HEATING • PUMPS*

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

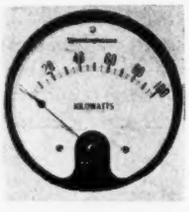



room thermostat. Unit can be used as relay for blower motors of unit heaters controlled from room thermostats and as a relay between room thermostats and condensing units in central plant-cooling systems. Can also be utilized as a relay between humidistat and humidification systems. However, it is designed primarily for use in conjunction with hold-fire timer and limit control to form complete stoker-control system.

*General Electric Co, Schenectady, N. Y.*

## Wattmeter

DIRECT-CURRENT instrument operates from standard 50 millivolt ammeter shunt. Construction is similar to that of usual dc shunted ammeter except that magnetic field is produced by an electromagnet energized from line voltage. This magnetic




circuit is made from Hipernik, an alloy of iron and nickel. Instruments available in conventional designs, or in shapes to match present switchboard instruments.

*Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

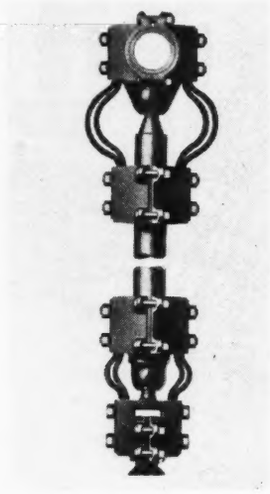
## Coating

SURFACE TREATMENT designed to prevent or minimize corrosion or "furring" of boilers consists of a coating which may be applied by dipping, brushing, spraying, etc, and which hardens when applied and exposed to light. Basic ingredients are colloidal graphite, electro-positive metallic filler, a hardenable organic colloid, and a hardening agent for the colloid, suspended in water. Composition may be applied at normal temperatures, or, if faster drying is desired, at around 100 C. After application, exposure to light, natural or artificial, hardens the organic colloid providing a corrosion-resistant coating with a relatively high degree of abrasion resistance.

*Acheson Colloids Corp, Port Huron, Mich.*

## Connectors

BURNDY electrical connectors, Types XTBS and XDBS are designed to permit expansion and contraction of a tap conductor at any angle to overhead bus or transformer stud. They will 'warp', according to

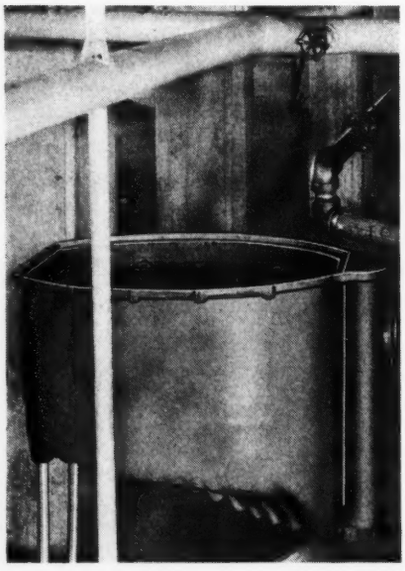


maker, with substation, but will not flop about loosely. Provide completely universal joint with ball-and-socket alignment guides incorporated in both stud connector and flexible T-connector.

*Burndy Engrg Co, 459 East 133rd St, New York, N. Y.*

## Separator

GALE CONDITIONER can be used, according to maker, wherever lubricants, fuel oil or other liquids are used in manufacturing or

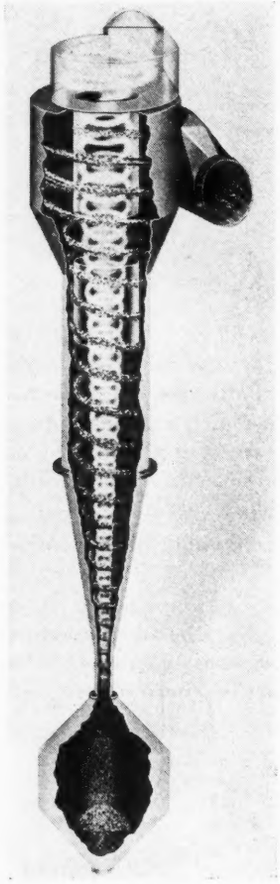


storing and where there is loss from leakage, dripping, seepage, etc. Unit also said to remove other substances such as coal, minerals, particles, etc, and condition water. Has no moving parts. Liquids of different specific gravities can be conditioned also.

*Gale Oil Separator Co, Inc, Chrysler Bldg, New York, N. Y.*

## Dust Collector

CYCLONE dust collector separates dust from air stream by centrifugal force, and according to maker, high efficiencies are obtained with relatively low backpressure due to careful proportioning. Air volume can be varied from rated capacity with changing efficiency, says manufacturer, but backpressure changes as the square of the volume ratio. Dust hopper, or storage



tanks, can be any design, providing they will handle efficiently capacities of dust to be collected. Dust collection cannot be permitted in collector proper. Dust discharge must be taken care of either while collector is in operation, or hopper must be supplied with double stage continuous discharge valve.

*American Foundry Equipment Co, 580 South Byrkit St, Mishawaka, Ind.*

## Steel Valve

"DURAVALVE JUNIOR" has Stellite seat welded integral to body. Maker claims this integral seat construction has proven

*(Continued on page 140)*

# TRIPLE PROOF

## ON HOW TO SAVE PRODUCTION DOLLARS WITH ALLIS-CHALMERS LO-MAINTENANCE MOTORS!

**Read These True Stories for the Inside Facts on Why Allis-Chalmers Lo-Maintenance Motors are First Choice with Men Who Want Record-Breaking Motor Performance!**

WHEN THE GOING gets tough and profits depend on performance — that's when you need Lo-Maintenance Motors more than ever!

For, don't forget — Allis-Chalmers Lo-Maintenance Motors are built to operate under the most severe conditions.

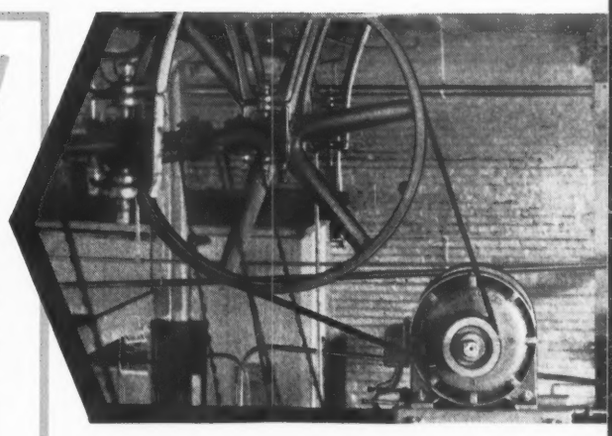
High carbon steel frame... indestructible rotor... Distortionless stator... no skimp or stint in materials and workmanship— all these are real reasons why Lo-Maintenance Motors hold an industry-wide reputation for standing up under conditions that many times wreck ordinary motors.

Get the complete Lo-Maintenance story. Call the engineer in the district office near you... or write Allis-Chalmers, Milwaukee.

A 1280

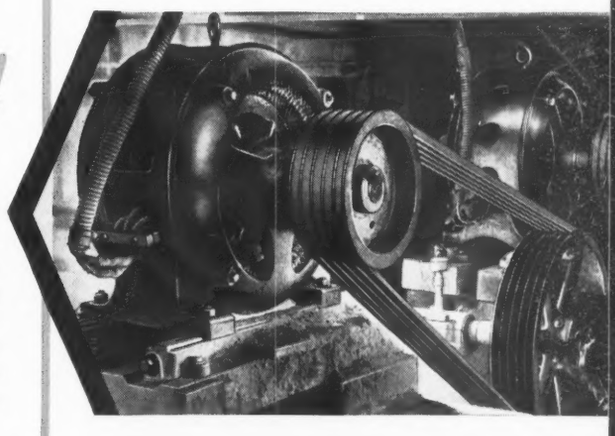
### NINE YEARS IN A DYE HOUSE!

ORDINARY MOTORS WERE cracking up in 12 to 14 months in the dye house of the Wilkes Hosiery Mills Co. Then they installed an Allis-Chalmers Lo-Maintenance Motor that made news! After nine years of service... that Lo-Maintenance Motor was running as perfectly as the day it was installed!



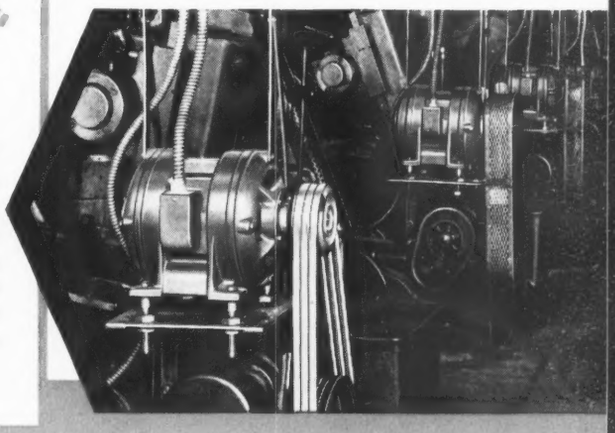
### 29 YEARS ON THE ROCKPILE!

TURNING ROCK CRUSHERS... with highly abrasive lime dust filling the air — these two 50 hp Lo-Maintenance Motors have been going 29 years without running up high repair or maintenance expenses for the Waukesha Lime & Stone Co.



### "WE'LL TAKE A CARLOAD!"

WHEN THE WARNER AUTOmotive Parts Division of Borg-Warner needed motors for a new plant, they checked motor operation in their other plants... found Lo-Maintenance led in performance and low cost. That's why they ordered a carload — 346 at one time!



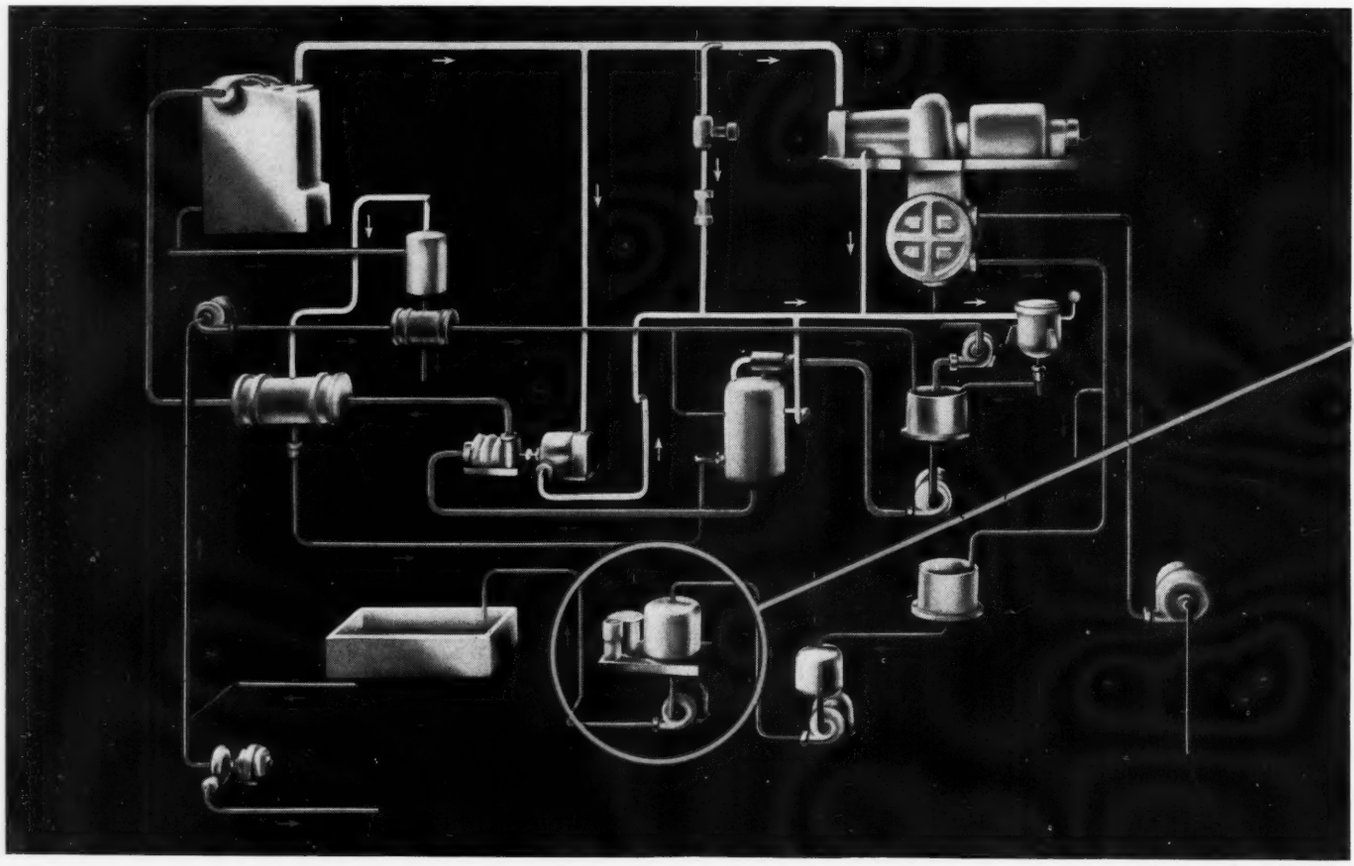
*Over 90 Years of Engineering Superiority Work for You When You Specify Allis-Chalmers!*

ALLIS-CHALMERS

MILWAUKEE·WISCONSIN

# FROM *GOOD* POWER HOOKUPS

## FOR FEEDWATER TREATMENT No. 3...



Courtesy—Power Magazine

**HOOKUP #22** **Heavy power load, and process demand for large quantities of hot water, influenced layout of this textile plant. Condensing turbine supplies power, with condenser acting as water heater; high vacuum is secondary. Warmed water is filtered and zeolite softened; storage pond absorbs unbalances. Most of water goes to mill, but some is further heated by blowdown for makeup. Auxiliary exhaust, bleed and reducing valve combine to supply l-p process.**

IN PLANNING a Feedwater Treatment System such as shown in the diagram at the right, several variations might be made, influenced by special requirements or local conditions.

The process of Base Exchange illustrated may not be in accord with your own plant... but the principle—as it pertains to "Good Valve Practice"—remains the same.

Commercial chemicals change scale-forming constituents of water to harmless sodium salts. Treatment tank resembles a pressure filter with chemical replacing the filtering material which must be regenerated occasionally with brine.

Provision is also made for backwashing the treatment tank, to clean out deposits, without discharging, however, any of the chemicals.

Here again, Valves recommended for the solution and brine lines are available in either Iron Body Bronze Mounted or All-Iron construction.

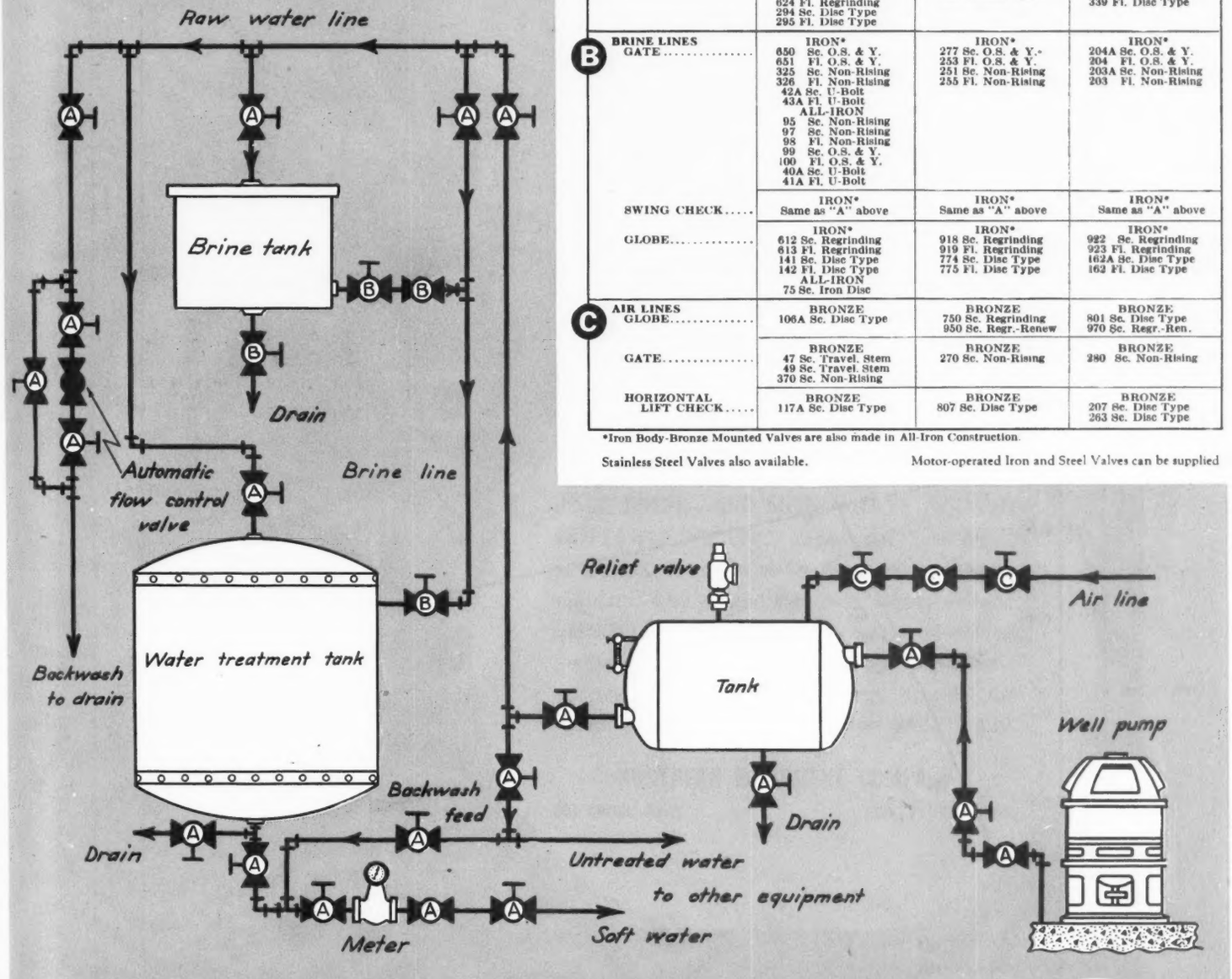
**NEXT MONTH—OIL BURNER CONNECTIONS**

IN VALVES *Jenkins* GIVES YOU EVERYTHING

# . . . TO *GOOD* VALVE PRACTICE

# *Jenkins* RECOMMENDS . . .

## CONNECTIONS FOR BASE EXCHANGE WATER TREATMENT




### REFERENCE CHART TO JENKINS FIGURE NUMBERS FOR FEED WATER TREATMENT No. 3

| | | Standard | Medium | Extra Heavy |
|---|---|---|---|---|
| A | FEED WATER GATE | BRONZE<br>47 Sc. Travel. Spindle<br>49 Sc. Travel. Spindle<br>370 Sc. Non-Rising<br>70 Sc. Non-Rising<br>71 Fl. Non-Rising<br>72 Sc. O.S.& Y.<br>73 Fl. O.S.& Y.<br>368 Sc. O.S. & Y.<br>IRON<br>325 Sc. Non-Rising<br>326 Fl. Non-Rising<br>650 Sc. O.S.& Y.<br>651 Fl. O.S.& Y. | BRONZE<br>270 Sc. Non-Rising<br>275 Sc. O.S.& Y.<br>IRON<br>251 Sc. Non-Rising<br>255 Fl. Non-Rising<br>277 Sc. O.S.& Y.<br>253 Sc. O.S.& Y. | BRONZE<br>280 Sc. Non-Rising<br>282 Sc. O.S.& Y.<br>IRON<br>203A Sc. Non-Rising<br>203 Fl. Non-Rising<br>204A Sc. O.S. & Y.<br>204 Fl. O.S. & Y. |
| | SWING CHECK | BRONZE<br>352 Sc. Disc Type<br>762 Sc. Regrinding<br>IRON<br>623 Sc. Regrinding<br>624 Fl. Regrinding<br>294 Sc. Disc Type<br>295 Fl. Disc Type | BRONZE<br>762 Sc. Regrinding<br>IRON<br>338 Sc. Disc Type<br>339 Fl. Disc Type | BRONZE<br>260 Sc. Disc Type<br>962 Sc. Regrinding<br>IRON<br>338 Sc. Disc Type<br>339 Fl. Disc Type |
| B | BRINE LINES GATE | IRON*<br>650 Sc. O.S. & Y.<br>651 Fl. O.S. & Y.<br>325 Sc. Non-Rising<br>326 Fl. Non-Rising<br>42A Sc. U-Bolt<br>43A Fl. U-Bolt<br>ALL-IRON<br>95 Sc. Non-Rising<br>97 Sc. Non-Rising<br>98 Fl. Non-Rising<br>99 Sc. O.S. & Y.<br>100 Fl. O.S. & Y.<br>40A Sc. U-Bolt<br>41A Fl. U-Bolt | IRON*<br>277 Sc. O.S. & Y.<br>253 Fl. O.S. & Y.<br>251 Sc. Non-Rising<br>255 Fl. Non-Rising | IRON*<br>204A Sc. O.S. & Y.<br>204 Fl. O.S. & Y.<br>203A Sc. Non-Rising<br>203 Fl. Non-Rising |
| | SWING CHECK | IRON*<br>Same as "A" above | IRON*<br>Same as "A" above | IRON*<br>Same as "A" above |
| | GLOBE | IRON*<br>612 Sc. Regrinding<br>613 Fl. Regrinding<br>141 Sc. Disc Type<br>142 Fl. Disc Type<br>ALL-IRON<br>75 Sc. Iron Disc | IRON*<br>918 Sc. Regrinding<br>919 Fl. Regrinding<br>774 Sc. Disc Type<br>775 Fl. Disc Type | IRON*<br>922 Sc. Regrinding<br>923 Fl. Regrinding<br>162A Sc. Disc Type<br>162 Fl. Disc Type |
| C | AIR LINES GLOBE | BRONZE<br>106A Sc. Disc Type | BRONZE<br>750 Sc. Regrinding<br>950 Sc. Regr.-Renew | BRONZE<br>801 Sc. Disc Type<br>970 Sc. Regr.-Ren. |
| | GATE | BRONZE<br>47 Sc. Travel. Stem<br>49 Sc. Travel. Stem<br>370 Sc. Non-Rising | BRONZE<br>270 Sc. Non-Rising | BRONZE<br>280 Sc. Non-Rising |
| | HORIZONTAL LIFT CHECK | BRONZE<br>117A Sc. Disc Type | BRONZE<br>807 Sc. Disc Type | BRONZE<br>207 Sc. Disc Type<br>263 Sc. Disc Type |

*Iron Body-Bronze Mounted Valves are also made in All-Iron Construction.

Stainless Steel Valves also available. Motor-operated Iron and Steel Valves can be supplied

**JENKINS BROS., 80 WHITE STREET, NEW YORK, N. Y.**

Bridgeport • Boston • Chicago Philadelphia • Atlanta • Houston

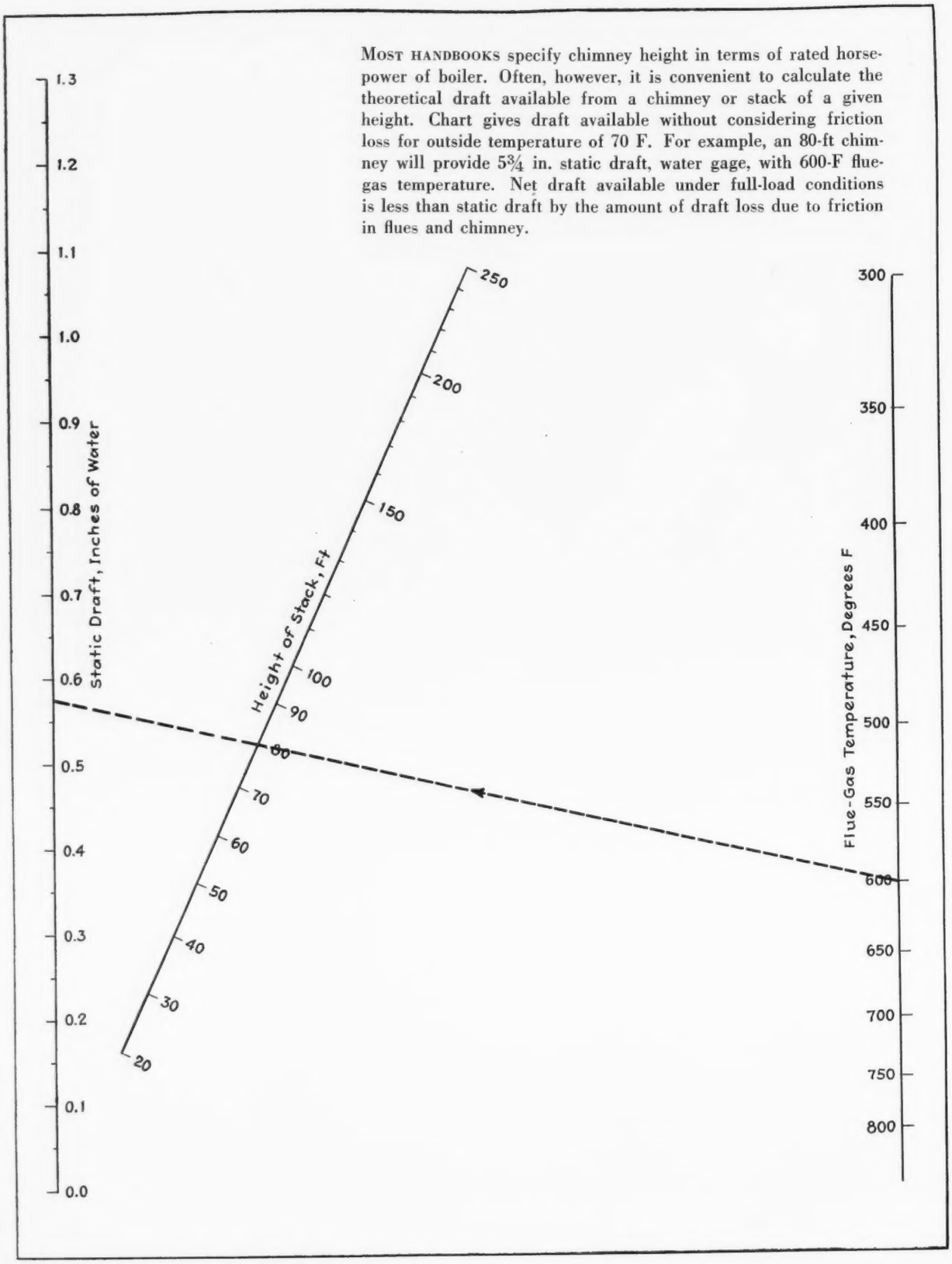
TRADE JENKINS MARK Jenkins Bros

**#22 OF A SERIES** designed to help in your selection of JENKINS VALVES

Number 98

# Static Chimney Draft

MOST HANDBOOKS specify chimney height in terms of rated horsepower of boiler. Often, however, it is convenient to calculate the theoretical draft available from a chimney or stack of a given height. Chart gives draft available without considering friction loss for outside temperature of 70 F. For example, an 80-ft chimney will provide 5¾ in. static draft, water gage, with 600-F flue-gas temperature. Net draft available under full-load conditions is less than static draft by the amount of draft loss due to friction in flues and chimney.



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American Car & Foundry Co. American Crystal Sugar Co. American Rolling Mill Co. Appalachian Electric Co. Barrett Co. Birmingham Electric Corp. Brooklyn Navy Yard Brightwater Paper Co. Bush Carnegie-Illinois Steel Corp. Celanese Corp. of America Celluloid Central Illinois Light Co. Coal Co. Cleveland Worsted Mills Co. Columbus & Southern Ohio Electric Co. Congella Power Station Congoleum-Nairn Co. Consumers Power Co. The Derby Gas & Electric Co. Detroit Edison Co. The Dow Chemical Co. Dunn Sulphite Paper Co. E. I. du Pont de Nemours & Co. Eddy Paper Corp. Eousta Paper Corp. Electric Reduction Co. Empire Power Co. Florida Power & Light Co. City of Fairmont, Minn. Fort Bend Co. Gatineau Electricity Department Fulton Bag & Cotton Mills Robert Gair Co. Inc. Hull Electric Supply Co. Humble Oil & Refining Co. Indiana Harbor Belt R. R. Co. Iowa City Light & Power Co. Jones & Laughlin Steel Co. City of Kansas City, Kansas Kentucky Electric Power Co. Kirkstall Power Station Lago Oil & Transport Co. Ltd. Libby Littlebrook Power Station Little Barford Power Station Long Island Lighting Co. Power Station Machinoimport Manshu Dengyo K. K. Marion-Reserve Power Co. Mathieson Alkali Works Manufacturing Co. Metropolitan Life Insurance Co. Nebraska Power Co. Nevada Consolidated Copper Corp. New Jersey Zinc Co. Newport Electric Supply Co. Norfolk & Western Ry. Co. North Carolina Pulp Co. North Eastern Electric Co. Norton Co. City of Ottawa Ohio Edison Co. Ohio Leather Co. Pan-American Refining Corp. Pacific Gas & Electric Co. Pennsylvania Power Co. Potomac Electric Power Co. Public Service Co. of Northern Illinois Puget Sound Power & Light Co. Quebec Power Co. Station Jacob Ruppert Brewery J. A. Riggs Tractor Co. Rochester Gas & Electric Corp. Light, Heat & Power Co. Sioux City Gas & Electric Co. Southern Pacific Co. Wales Electric Co. State University of Iowa Tennessee Coal, Iron & Railroad Co. Texas Power & Light Co. Works Utah-Idaho Sugar Co. Utah Power & Light Co. United Shoe Machinery Corp. United States Rubber Co. U. S. Naval Ordnance Plant Virginia Electric & Power Co. Western Cartridge Co. Westinghouse Electric & Manufacturing Co. Weston West Midlands Electric Co. West Penn Power Co. West Virginia Pulp & Paper Co. Winchester Repeating Arms Co. Worcester Co. Youngstown Sheet & Tube Co.

ALL THESE—AND MORE—HAVE BOUGHT COPES FLOWMATIC, announced here just 3 years ago. No other steam-flow type feed water regulator ever gained such wide acceptance so quickly. If you want closer water level control for modern boilers, with simple equipment needing no "expert" servicing, specify the COPES Flowmatic. Write for new Bulletin 429.

**NORTHERN EQUIPMENT COMPANY**

901 GROVE DRIVE ERIE, PENNSYLVANIA

COPES FEEDS BOILER ACCORDING TO STEAM FLOW-AUTOMATICALLY

GET CLOSER LEVEL CONTROL WITH THE FLOWMATIC

★ REGULATOR

# ENGINEERS' BOOKSHELF

## Engineering Handbook

GENERAL ENGINEERING HANDBOOK (Second Edition, 1940). *Editor in Chief, C E O'Rourke, Professor of Structural Engineering, Cornell University. Published by McGraw-Hill Book Co, 330 W 42nd St, New York, N. Y. 1120 pages, 5½x8 in., illustrated. Price $4.00.*

Revised edition of this compact handbook brings up to date fundamentals of theory and practice in mechanical, civil and electrical engineering. Basic information is presented in brief hard-boiled form. Chapters include mathematics, materials, mechanics, hydraulics, structures, concrete, surveying, highways, sanitation, machines, pumps, compressors, thermodynamics, heating and air conditioning, electrical engineering.

## Mechanics

PRACTICAL MECHANICS AND STRENGTH OF MATERIALS (Third Edition, 1940). *By C W Leigh and J F Mangold, Armor Institute of Technology. Published by McGraw-Hill Book Co, 330 W 42nd St, New York, N. Y. 498 pages, 5x7 in., 441 illustrations, appendix. Price $3.00.*

Basic text for classroom instruction has been enlarged and scope increased, and includes many illustrative examples and worked-out problems. Treats mechanics and materials as one combined subject. Recommended for brushing up men engaged in practical construction work, but requires working knowledge of algebra and trigonometry.

Chapters include stresses, welded and riveted joints, properties of materials, forces and moments, friction, structures, beams and columns, torsion and shear.

## History

POWER IN TRANSITION (1940). *By Ernest R Abrams. Published by Charles Scribner's Sons, 597 5th Ave, New York, N. Y. 318 pages, 6x8 in. Price $3.00.*

Power generation, transmission and distribution in the United States has passed through many phases. The author in this book follows through all of them from 58 years ago, when Thomas A Edison placed a tiny electric generating plant in operation in New York City, down to the present era of government ownership of power generating plants and systems. The first workable electric service systems were wholly the product of private enterprise. Then, as the advantages in comfort, convenience, efficiency of electricity were demonstrated the demand for this service became so great that private enterprise could not keep pace with it and public ownership of electric utilities increased. Thus, in 1902 close to 10% of utility generating capacity was in these plants. During the next 30 years a combination of circumstances arose that discouraged public participation in the electric-service field so that by 1930 less than 5% of the electric consumers were supplied from these plants. In an attempt to combat the ravages of the business depression through stimulation of employment the Federal Government has encouraged a trend back to public ownership of electric utilities.

It is to this latter phase that a large part of this book is devoted. The author divides this country into six geographical areas and treats the public water-power project in each of them. A vast amount of statistical data are given on power generation, size of rivers and their drainage areas, initial and ultimate size of the power developments, flood control, navigation cost of development, future possible power uses, etc. To those who would know more about our water-power problems this book can be highly recommended.

## Mathematics

ELECTRICAL SHOP MATHEMATICS (1940). *By Herbert Druery Harper, Jamaica Vocational High School, New York City. Published by D Van Nostrand Co, Inc, 250 Fourth Ave, New York, N. Y. 145 pages, 6 x 9 in.; illustrated; several tables; cloth binding. Price, $1.50.*

Written to meet the needs of students in secondary schools who are studying electrical practices and installations, this book is well suited to practical electrical workers who want to know more about electrical calculations. The text is devoted largely to mathematical problems of simple electrical circuits. These problems are practical and the type found in everyday field work; nothing more than a knowledge of simple arithmetic is needed to master the entire book. Sections deal with Ohm's law, electric circuits, measuring instruments, batteries, electric work and power, wire sizes, dynamos, estimating costs, and general applications.

## Science

THE ROAD TO MODERN SCIENCE (1940). *By H A Reason. Published by D Appleton-Century Co, 35 W 32nd St, New York, N. Y. 297 pages, 5½ x 8 in., illustrated, cloth binding. Price, $3.00.*

This is one of the most interesting and instructive of the many books on the history of science. The work is divided into two parts. In the first, the trail begins with when man first made his appearance on earth, some hundreds of thousands of years ago, and we are shown how the human race gradually accumulated practical knowledge and used it for the business of living, until we come to the ancient Greeks. These were the first people to pursue knowledge for its own sake, and with them science really had its beginning.

The trail winds, now clear, now faint, now straight, till the intellectual giants of the 16th century laid the foundation for our modern scientific achievements. In the second part of the book the trail branches into chemistry, magnetism and electricity, the development of prime movers, waves of many kinds, astronomy, biology and closes with a chapter on the three regions that are occupying the attention of the greatest scientists of today. These are the realm of the extremely small, found inside the atom; the realm of the immensely large, the great universe about us; and that mysterious complex world of life itself. The book gives an intensely interesting picture of the development of the sciences and of the men who blazed the trails. Written for the layman, it will be found equally informative by engineers and other technicians. To those who enjoy popular journeys into science, this book can be heartily recommended.

## Electricity

FUNDAMENTALS OF ELECTRICITY AND ELECTROMAGNETISM (1940). *By Vernon A Suydam, Professor of Physics, Beloit College. Published by D Van Nostrand Co, Inc, 250 4th Ave, New York, N. Y. 690 pages, 5½ x 8½ in., 337 illustrations, cloth binding. Price, $4.75.*

This book is the outgrowth of a system of lecture notes arranged for a college course on electricity and magnetism. It is intended as a basis for an approach to experimental and theoretical electricity and electromagnetism and to provide a solid foundation upon which an electric-power and communication engineering education may be built.

The book is divided into 25 chapters and covers practically all branches of electricity and magnetism from electrostatics to electron tubes and their uses. It assumes that the student has completed a course in calculus, but the author has endeavored to lead the student by easy progressive stages from the simple to the more complex.

## Brief Reviews

BOILERS, SUPERHEATERS, ECONOMIZERS, AIR HEATERS, AND PIPING (1939). *Published by Edison Electric Institute, 420 Lexington Ave, New York, N. Y. Price $.80 to members and employees, $2.00 to non-members in U. S., $2.15 in foreign countries.*—Report of the Boilers Subcommittee of the Prime Movers Committee, Edison Electric Institute, contains statements by subcommittee, operating companies and manufacturers, covering operating and design problems related to boilers, superheaters, etc, together with descriptions of new developments.

ELECTRIC POWER STATISTICS—1939. *Published by Federal Power Commission, Washington, D. C. Report and Supplement, price $.50 for both.*—Report (No. FPC S-4) contains data on production of

*(Continued on page 188)*

# NEW PROCESS FOR SILICA REMOVAL

★ ★ ★

THE Permutit Company is pleased to announce, after several years of research, a process for removal of silica from high-pressure boiler feedwater.

This process is commercially perfected and is already in successful operation. It has 5 major advantages:

1. Eliminates Silica Scale and Deposits—Reduces silica content to any desired degree.
2. Economical—Uses moderate amounts of low cost reagents.
3. Reagents used do not add soluble by-products.
4. Adaptable to Hot or Cold Lime Soda Process.
5. Applicable to new or existing equipment.

"PERMUTIT"*
WATER CONDITIONING
Headquarters

*Trademark Reg. U. S. Pat. Off.

Write for bulletin. Address The Permutit Company, Dept. A, 330 West 42nd St., New York. For free water analysis—send for free sampling container.

"ZEO-KARB"* · ZEOLITE AND ACID · HOT LIME SODA · LIME ZEOLITE · INTERNAL

# "AMERICAN" MEANS . . .

**A***dequate preparation for defense,* in materials, machines, and methods, as well as men. Muddling through is exciting, but dangerous.

**M***oderation that avoids witch-hunting and blacklisting.* Justice combines punishment for traitors with the understanding that an accent is no index of alienism.

**E***limination of all "isms,"* be they fascism, communism, or even republicanism or democratism—as well as the absolutism that maintains everyone else is out of step. In emergency, politics is adjourned.

**R***espect for the flag, the Government, and Christian ideals and institutions.* America is not a hyphen-nation. Sincerity must be the keynote of thought as well as deed. True loyalty to America demands more than lip service.

**I***ndividual clear thinking that resists all propaganda and pressure groups,* regardless of objective, Freedom and equality are basic in any American's creed, just as are . . .

**C***ooperation and understanding.* No government can be all presidents, and no army all generals. Sincerity and the ability to work with others must be preserved as diligently as the right to think and to criticize constructively.

**A***lertness against treachery and treason.* Guard against them all, whether the fifth-column word, the sabotaging deed, or even the defeatist thought, regardless of where they appear. Don't sell America short.

**N***o meddling with other nations—and no toleration of meddling with America.* Innate pride in, and defense of, the American way of life are as essential as knowing the words of "The Star-Spangled Banner."

George Edwards

Engineer

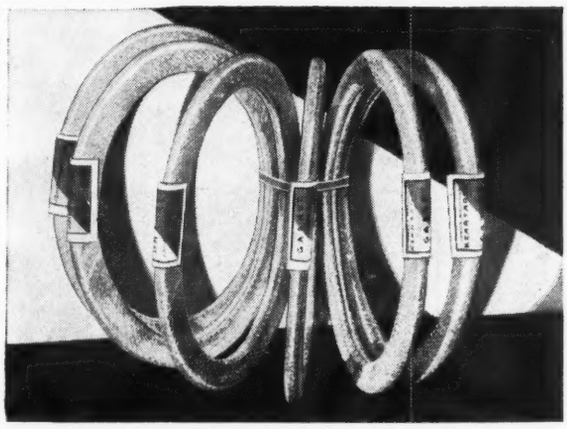
## THE AMERICAN'S CREED

I believe in the United States of America as a Government of the people, by the people, for the people; whose just powers are derived from the consent of the governed; a democracy in a republic, a sovereign Nation of many sovereign States; a perfect Union one and inseparable; established upon those principles of freedom, equality, justice and humanity for which American patriots sacrificed their lives and fortunes. I therefore believe it is my duty to my country to love it, to support its Constitution, to obey its laws, to respect its flag, and to defend it against all enemies.

—William Tyler Page. (Adopted by the House of Representatives, April 3, 1918).

## KEEPING 'EM ROLLING

By WESTCOTT



**J-M KEARSARGE BOILER GASKETS:** This better gasket presents an unbroken, rounded shoulder on the side exposed to pressure . . . gives a permanently tight seal. For boiler handholes, manholes and tube plates.

JOHNS-MANVILLE JM PRODUCTS

## P. S. THEY DID! . . . *with tougher, tighter-sealing J-M Kearsarge Boiler Gaskets*

FREQUENT tie-ups for packing or gasket replacements mean more than just a few dollars spent for materials. That condition costs plenty in idle equipment, time and labor charges. Yet much of this expense can be saved by using materials specially built to stand up longer in tough service. The next time you have a replacement job, try J-M Packings and Gaskets and you'll find out what real packing economy means. For more than 60 years, these J-M materials have been establishing outstanding records for dependable, economical service. For details on the complete J-M line, write for the J-M Packing Catalog. Johns-Manville, 22 East 40th Street, New York, N. Y.

# JOHNS-MANVILLE PACKINGS & GASKETS

***THERE'S A DISTRIBUTOR NEAR YOU***

# Combustion Efficiency at a GLANCE

## "RANAREX"*

*Mechanical $CO_2$ Indicator and Recorder*

- Only Mechanical $Co_2$ Meter
- Simple, rugged, trustworthy
- Readings Almost Instantaneously
- Permanent 24-hour Record
- Operates on Lighting Circuit
- No orifices, chemicals or fragile parts—No time lag
- Accurate within 3/10 of 1% of $CO_2$
- Saves up to 10% on Fuel

**FREE BOOKLET**

Write The Permutit Company, Dept. A, 330 West 42nd St., New York

**PRODUCT OF "PERMUTIT"***

* Trade Mark Reg. U. S. Pat. Off.


## Diesel Lube Oils

*(Continued from page 99)*

continuously purified, (2) a part of the oil is continuously purified, (3) the oil is purified periodically in batches. Each system requires a purifier, of which there are three distinct types: settling tank, centrifuge, and filter.

The operator of the small plant may construct a simple and inexpensive oil-purification plant similar to that shown in the sketch. In this batch settling method, the used oil should be heated to about 180 F and allowed to settle for 15 or 20 days. It also helps to introduce a small amount of boiling water to which has been added about a lb of soda ash (this amount of soda ash is sufficient to treat 50 gal of oil). First agitate the water and oil, and then allow the liquid to rest quietly. As the water sinks to the bottom of the tank it helps wash the impurities from the oil. These will accumulate in the form of a sludge layer between the clean oil at the top and water at the bottom.

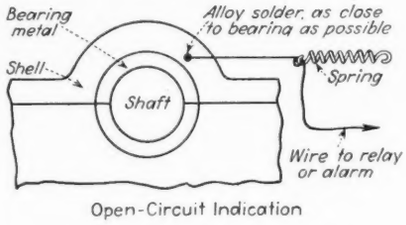
## Readers' Problems

*(Continued from page 112)*

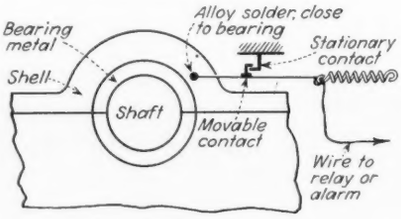
alarm, fasten a wire on or near the bearing, using the alloy solder. With a spring rigged as shown, the circuit will open and give an alarm through a low-voltage, low-cost relay-operated howler.

In the second sketch, showing a closed-circuit indicator, the melting of the solder releases the spring which brings the copper contacts together to give the alarm. In both cases, proper insulation must be used where necessary. In either case, indicator lamps can be used to give a quick checkup on the faulty bearing, by either lighted or dark lamps or a combination of both.

*Shiprock, N. Mex.* J F MAHER

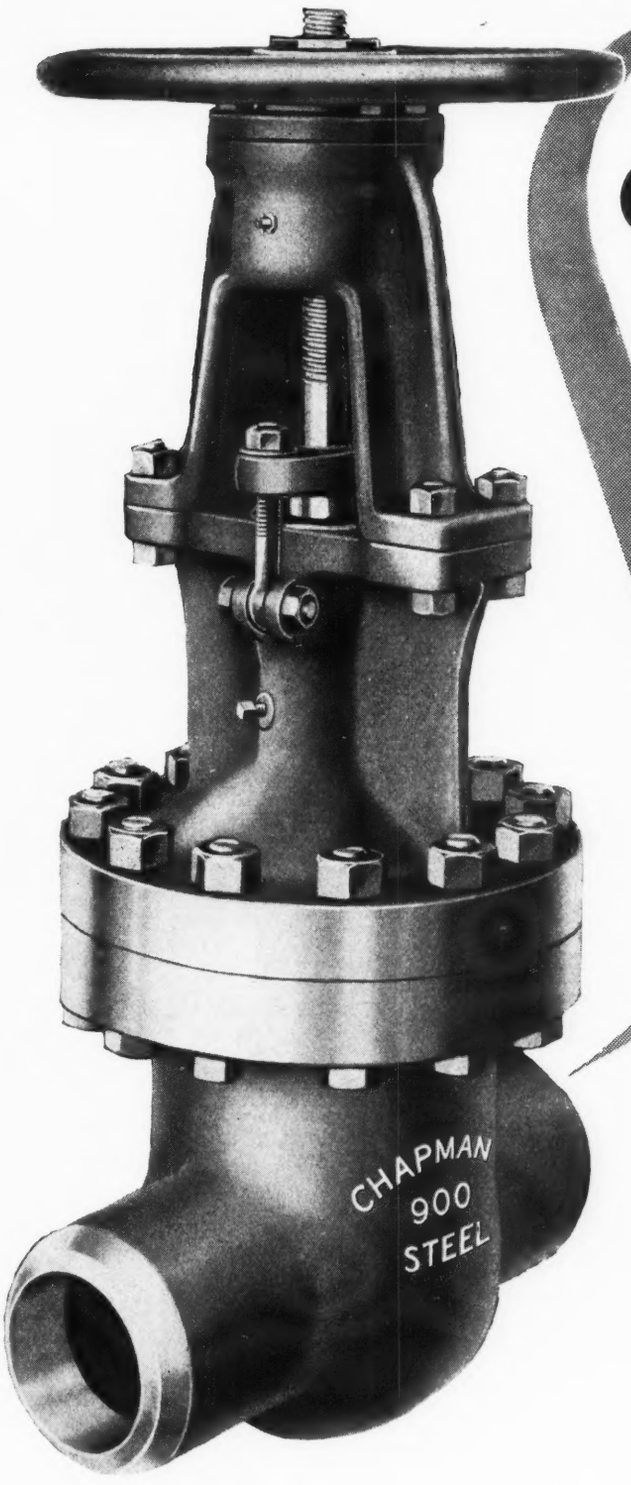



Open-Circuit Indication




Closed-Circuit Indication

# One Thing THEY HAVE In Common



Take a trip through power plants being built today, and look at the name on the valves. There, in bold, steel letters, you see a single word—CHAPMAN. And for good, important reasons.

With the complete Chapman Line it is possible to build your entire flow control up to highest possible standards . . . standards based on extensive research, experience and precision workmanship . . . standards backed by alloys best suited for special service requirements, poured, heat-treated and tested under direct metallurgical control in Chapman's own foundries.

For gate, globe, check and angle valves—for valves handling up to 1000°F and 2500 lbs.—for Chromium, Nickel, Molybdenum alloy valves—simply write one word in your specifications—CHAPMAN.

**THE CHAPMAN VALVE MFG. CO.**

*Indian Orchard, Massachusetts*

**CHAPMAN POWER PLANT VALVES**

GOLDEN-ANDERSON

Specialty

VALVES

STEAM PRESSURE REDUCING

To insure a uniform terminal pressure on varying capacities, employ this superior G-A Steam Pressure Reducing Valve. It is particularly adaptable for intermittent or dead end service. Furnished in sizes ranging from 2½" to 12", it is of Double Extra Heavy cast iron, with a semi-steel, or cast steel body and bonnet. Trim consists of either bronze, monel metal or stainless steel. Efficiently handles 125 lbs. to 400 lbs. of saturated or superheated steam. Pilot control may be located remotely from the main valve. For a free copy of the latest G-A catalog . . . write today . . . it contains detailed construction and application data on the complete line of Golden-Anderson Specialty Valves.

*also*

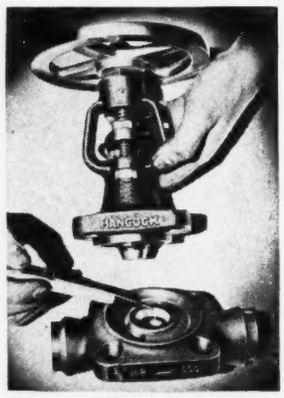
*Altitude Control . . . Throttle and Emergency Stop . . . Check . . . and other types of valves.*

Golden-Anderson Valve Specialty Co.

Fulton Bldg. • • • Pittsburgh, Pa.

# New Plant Equipment

*(Continued from page 128)*




superior to any other based on experience in 1500-lb work. Valve has body and bonnet of carbon-molybdenum steel, giving it a temperature rating of 950 F at 600-lb pressure.

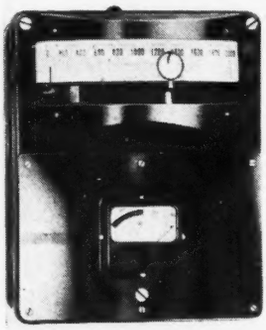
*Hancock Valve Div, Manning Maxwell & Moore, Inc, Bridgeport, Conn.*

## Correction

In Power for August, page 122, the address of the Photoswitch, Inc, makers of a pilot relay described in these columns, was given as 21 Chestnut St, Philadelphia, Pa. This should have been 21 Chestnut St, Cambridge, Mass.

## Pyrometer Controller

Moving parts in control circuit are eliminated in electronic pyrometer controller. Pointer of millivoltmeter movement is not engaged or retarded at any point within its normal operating range, thereby leaving it free to indicate continuously tempera-



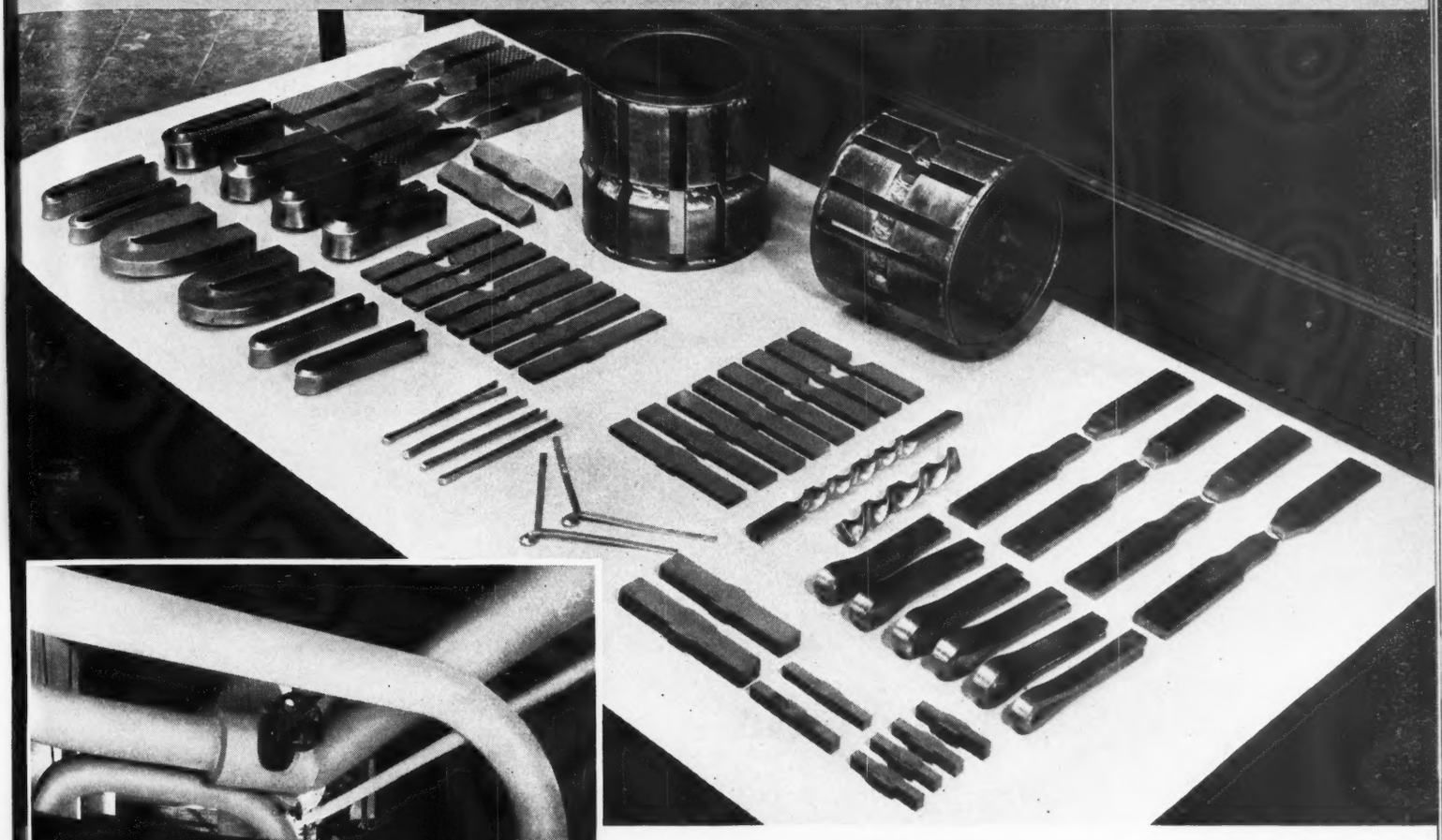
ture under control. Control is by means of new electronic circuit, using a single high-output, all-metal-type vacuum tube. Milliammeter on front of instrument indicates condition of control circuit at all times.

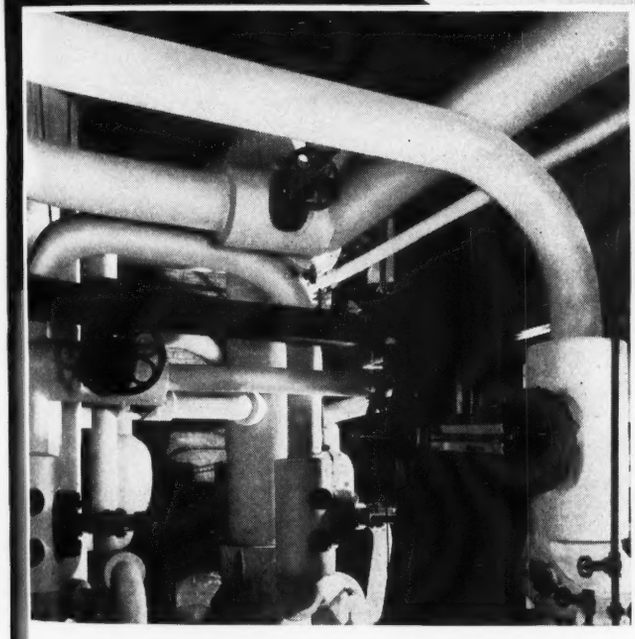
*Bristol Co, Waterbury, Conn.*

## Conductive Compound

Containing colloidal graphite, small amounts of hardenable organic colloid, and a hardening agent, coating is used to

# Laboratory control of welding at PITTSBURGH PIPING





*Above:* Typical high pressure, high temperature all-welded steam piping installation. Over 500 welds are made during the pre-fabrication and erection of such a system.

*Top:* Samples of chrome-moly and carbon-moly piping welded specimens prepared for appearance and physical tests. In the center are appearance tests showing method of "build-up" of both vertical and horizontal welded connections. Other samples have been tested for weld ductility by bending and strength characteristics by tension tests.

## GUARANTEES—Better, Safer High Temperature Piping

With modern steam generating systems calling for increased temperatures and higher pressures, the importance of welding in fabricating the piping cannot be over-emphasized.

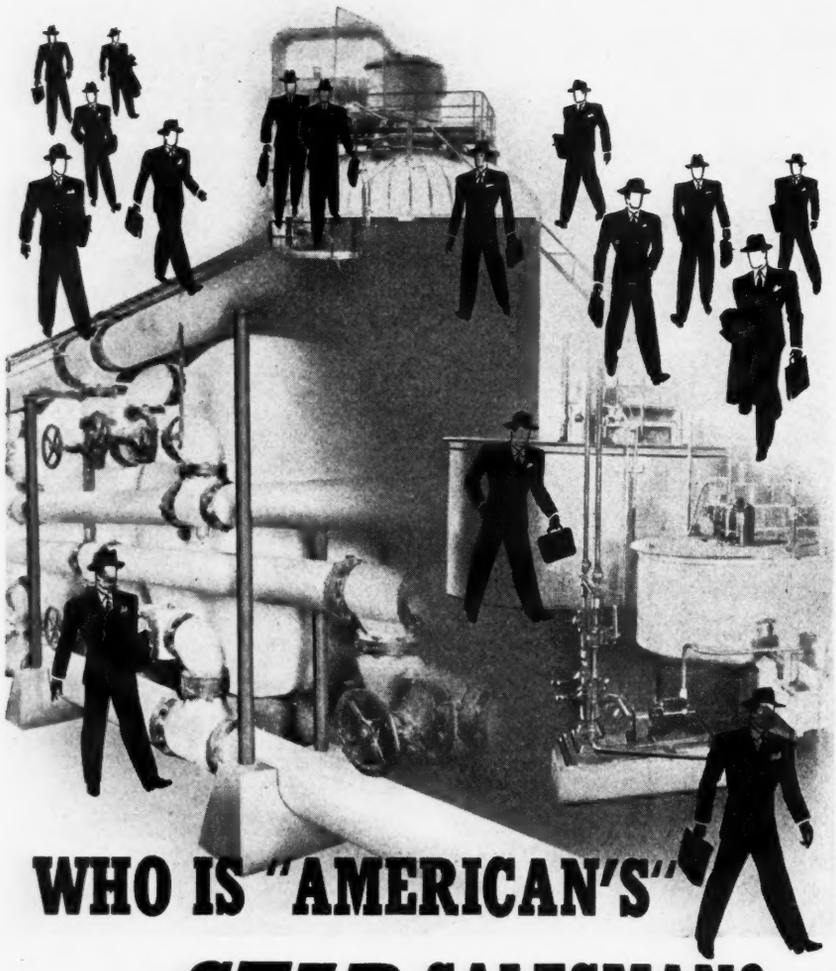
At Pittsburgh Piping, all welding procedure and welders' qualification tests for high pressure, high temperature piping are made in strict compliance with various codes and specifications, such as the A.S.M.E. Power Boiler Code, A.S.A. Power Piping Code, etc., under the direct supervision and control of our metallurgical laboratory. Examinations of welding on pre-fabricated assemblies are conducted in the shop as work progresses. In the laboratory are necessary modern facilities for the preparation, examination, heat treatment, and photomicrography of metallurgical specimens.

Such scientific laboratory control of welding eliminates guesswork, and guarantees better, safer piping fabrication.

**PITTSBURGH PIPING & EQUIPMENT CO.**
**10 FORTY-THIRD STREET PITTSBURGH, PA.**

Woolworth Bldg., New York Occidental Bldg., Indianapolis Peoples Gas Bldg., Chicago Union Guardian Bldg., Detroit
Public Sq. Bldg., Cleveland 10 High St., Boston Liberty Life Bldg., Charlotte 525 Market St., San Francisco

*Pittsburgh Piping*



# WHO IS "AMERICAN'S" *STAR* SALESMAN?

**HE DOES NOT . . .** Make an actual call . . . carry a kit . . . tell stories or jokes . . . discuss politics or wars.

**YET . . .** He is the Star Salesman for American Equipment, and is responsible for the ever increasing volume enjoyed by the American Water Softener Company.

**HE IS . . .** The enviable and unexcelled REPUTATION of this company . . . more than 40 years of designing and building Water Refining Equipment that is a good bargain for the purchaser.

**WHY NOT . . .** Put this Star Salesman to work for you? He'll cost you nothing . . . if you use him to help solve your Boiler Feed Water problems. Otherwise you may forego the benefits of his vast accumulated experience. Write for American Literature.

*The* **AMERICAN WATER SOFTENER CO.**

**WATER REFINING EQUIPMENT HEADQUARTERS**

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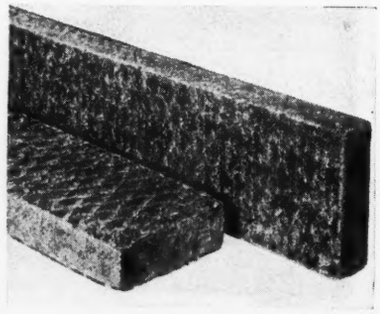
PHILADELPHIA, PENNSYLVANIA . . .

make fabrics electrically conductive. Solution, applied at normal or slightly elevated temperatures to promote rapid drying, hardens upon exposure to light.

*Acheson Colloids Corp, Port Huron, Mich.*

## Insulating Block

B-H MONO BLOCK covers full range of temperatures up to 1600 F. is fabricated of B-H Black Rockwool, felted and bonded together to form a semi-hard block light in weight, easily cut and easily fitted around equipment having curved surfaces

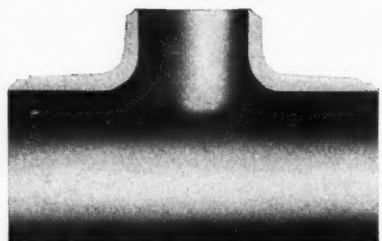


or large radii as well as flat surfaces. Is specially adapted to boiler walls, breechings, ducts, tanks, towers, etc. Made in lengths from 18 to 36 in., widths from 6 to 12 in. and thicknesses from 1 to 4 in.

*Baldwin-Hill Co, 575 Klagg Ave, Trenton, N. J.*

## Welding Tee

SEAMLESS-STEEL welding tees have metal placed at points of stress, instead of useless metal added throughout tee. This makes for full pipe strength, according to



manufacturer. Another improvement over other types, maker says, is that longer outlets are provided for greater ease in lining up and welding.

*Tube-Turns, Inc, 251 East Broadway, Louisville, Ky.*

## Motor Shunt Bead

GLAZED CERAMIC motor shunt bead is made of AlsiMag, and has perfectly smooth inside area which is lubricated by a glazed coating. New beads available in wide range of sizes. The glazed coating, according to manufacturer, gives all advantages of imported glass bead with none of its disadvantages.

*American Lava Corp, Chattanooga, Tenn.*

Your micrometer can tell you — truthfully — more about the uniform wall thickness of Republic ELECTRUNITE Boiler Tubes than you can learn in any other way.

"Mike" one of these electric resistance welded boiler tubes. You'll find that the total wall tolerance never varies more than .005" in any cross-section. "Mike" a carload, if you wish. You'll discover that the wall thickness of any number of tubes never varies more than .020".

What does this mean? Just this: Combined with uniform diameter, concentricity and high ductility, it makes installation easier, insures tight joints and reduces danger of over or under rolling and of splitting or fracturing. It means low, even thermal stress, uniform heat transfer and consistent weight. It means lower installation costs, dependable boiler operation and long life.

Let us send you complete information on Republic ELECTRUNITE Boiler Tubes. Let us tell you about their fine, scale-free surface and other advantages. Let us give you names of the many manufacturers and users who specify them regularly. Write Steel and Tubes Division, Republic Steel Corporation, Cleveland, Ohio.

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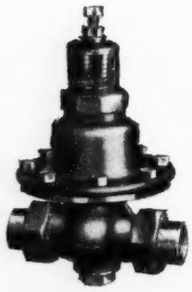
# ELECTRUNITE

**ELECTRIC RESISTANCE WELDED BOILER, CONDENSER AND HEAT EXCHANGER TUBES**

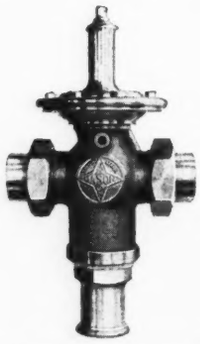
# PREVENT *Chills and Fevers* IN YOUR PLANT

***Be Sure Your Steam Heating System Is Modern, Steam-Saving and Always on the Job***

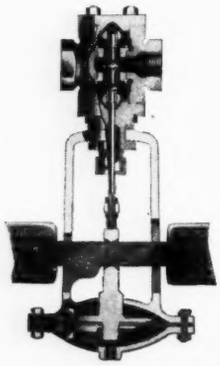
MASONEILAN



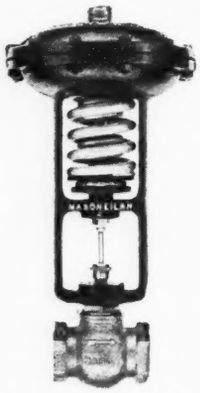
**No. 33**—for small unit heaters or single radiators. Has bronze body, stainless steel trim, union ends, tight shut-off. Sizes up to ¾". Pressure ranges between 2 and 100 lbs.



**No. 12**—for low pressure systems and unit heaters. Pilot operated. Bronze body, stainless steel trim, union ends, tight shut-off. Bronze sizes up to 2". Iron sizes 2½" to 4". Pressure range 0 to 15 lbs.



**No. 236-A**—for general heating systems. Very sensitive. Standard iron bodies with bronze trim or extra heavy iron bodies with stainless steel trim, sizes up to 8". Pressure ranges between ½ and 40 lbs.



**No. 509**—for general or unit heating systems. Bronze body with bronze or stainless steel trim, screwed ends. Sizes up to 1½". (Larger sizes also available.) Pressure ranges between 2 and 150 lbs.

Now is the time to begin checking up on your heating system — *before* you need it. And while you are checking make sure your steam pressure regulators are the right type for your particular system. If they need replacing we suggest that you investigate Masoneilan Regulators — the line that is "built up to the job, not down to a price." Savings in maintenance and extra long life often more than pay for the regulator. Ask your mill supply distributor for complete details on these regulators—or write for Bulletin No. 69.

**MASON-NEILAN REGULATOR CO.**

**1186 ADAMS ST., BOSTON, MASS., U. S. A.**

New York Buffalo Philadelphia Pittsburgh Chicago St. Louis Tulsa Houston Los Angeles Mason Regulator Co. of Canada, Ltd., Montreal

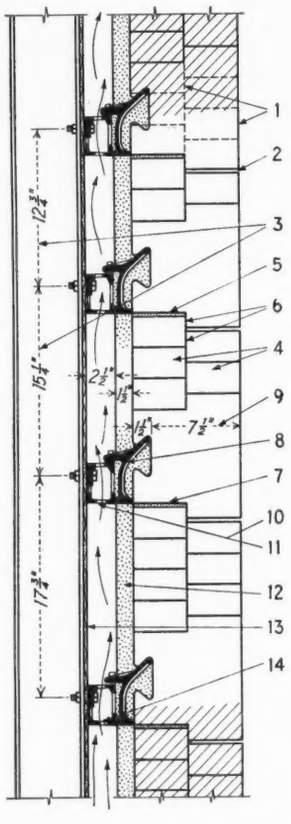

## Spot Welder

TWO-GUN portable spot-welding unit designed to eliminate necessity for duplicate welding equipment in heavy-duty service. Unit is equipped with pneumatic tires and is wheeled from one assembly to another. Only connections needed in new location are air lines, for air-hydraulic pressure booster; water lines, for cooling welding cables, points and transformers; and power lines.

*Progressive Welder Co, 3050 East Outer Drive, Detroit, Mich.*

## Insulated and Air-Cooled Wall

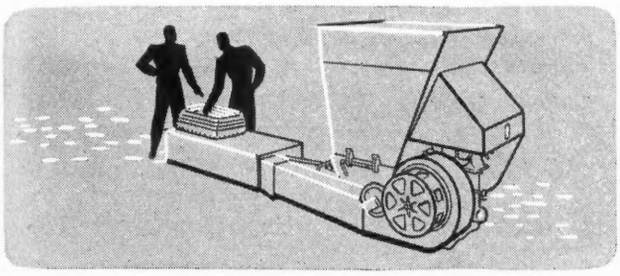
WALL is so designed that insulation can be placed between the refractories and their horizontal box castings, leaving 90% of wall supporting metal outside insulation and preserving same longer. In addition, maker says, all metal within insulation consists of individual pieces of limited size so that cumulative growth is impossible. In illustration, (1) each tile is a multiple of standard fire brick dimensions and could be temporarily repaired with standard fire brick; (2) tiles and castings of each belt are completely separated; (3) heights of belts varied without changes in tile or castings; (4) 25 to



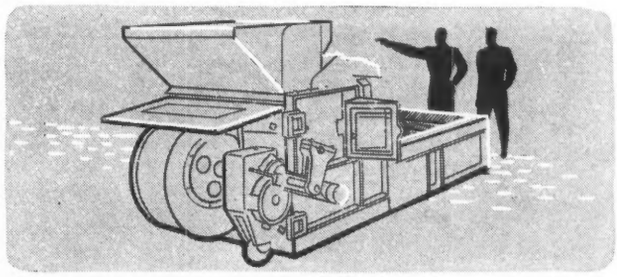

40% of all wall can be standard fire brick; (5) offset expansion joints, formed by notch in tiles, protect compressible packing; (6) notch in tile offsets all brick joints. These joints are cemented with air setting, high-temperature cement. (7) No metal shoes or supports imbedded within refractories; (8) individual tile-supporting fingers entirely back and protected by supporting tile;

# EVERY WHITING STOKER INSTALLATION *must* BE CORRECT!

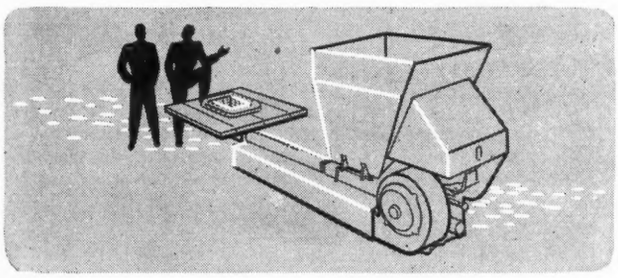
With Whiting, a stoker installation that "*comes close*" to doing a correct, efficient job is not enough. That is why Whiting makes such a complete line of coal-burning equipment—why this line has capacities that range all the way from 15 lb. to 12,000 lb. per hour.



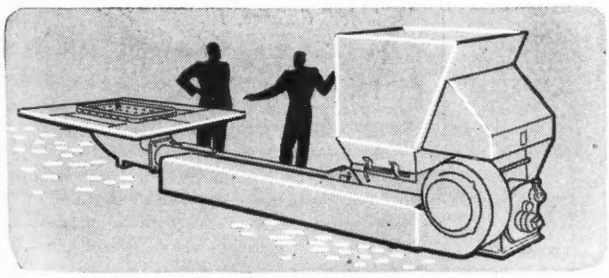
**WHITING 100—150 LB. CAPACITY**
Available in both open and closed hopper models. (Automatic air control, illustrated, is available on all Whiting Commercial Stokers at slight extra cost.)



**WHITING HORIZONTAL—COMPRESSION FEED STOKER**
Provides a uniform fuel bed, free from holes. Gives progressive combustion. Continuous ash removal. Assures you low-cost steam from low-priced coal.



**WHITING 200—250 LB. CAPACITY**
With Whiting's wide range of capacities there is a model designed to solve any heating problem economically.



**WHITING 350—800 LB. CAPACITY**
Whiting makes a complete line of models in the 350—800 lb. range so that every Whiting installation will be correct.

## WHITING A PIONEER IN STOKER MANUFACTURE AND IMPROVEMENT

Whiting—a 56-year-old company—has been manufacturing stokers for over 14 years. Thousands of successful Whiting installations, the length and breadth of America, are successfully conserving fuel dollars for their owners.

## WHITING ENGINEERS WILL ANALYZE YOUR JOB

No matter how difficult your heating problems may be, Whiting engineers will gladly analyze them for you and give you the correct answer. If you would like to have a Whiting engineer make a complete survey of your heating equipment, *without cost or obligation*—send the coupon below to Whiting today. Remember Whiting makes a complete range of stoker sizes suited to every heating condition. Whiting engineers are always glad to cooperate and work with engineers and architects. Be sure to get a Whiting bid on every heating job.

## WHITING STOKERS ARE "ENGINEERED FOR THE JOB"

Whiting stokers are engineered not only for design and workmanship, but *to the special requirements of the individual job.*

***There's a Fuel Saving Whiting Stoker for Every Heating Need***

**WHITING CORPORATION**
Manufacturers of Commercial Cranes and Material Handling Equipment and All Types of Special Machines
*Harvey, Illinois*

WHITING CORPORATION, Dept. P 9, Harvey, Illinois
I'd like to have a Whiting survey of my heating equipment. I understand this will not obligate me in any way.

*Name*.....*Position*.....

*Firm Name*.....*Street*.....

*City*.....*State*.....

"You can bank on FAIRBANKS"

# You're Money Ahead with FAIRBANKS VALVES

There are good sound dollars and cents reasons why it will pay you to use Fairbanks Valves.

Only the best materials—the most expert workmanship—are used in building these valves. And they must pass the most rigid inspection before they leave our factory.

Consequently, they are easy to operate, seat perfectly, are easy to repack and close tightly at all times. Long life and low maintenance cost is assured.

Still further economies are effected if you use Fairbanks *Renewable* types, as worn seats and discs can be replaced in a few minutes, at a small fraction of the cost of a new valve, without removing the body from the pipe line.

Fairbanks Valves are made in bronze and iron, in types and sizes to meet almost every specific requirement.

Ask our distributor to show you the many outstanding features of Fairbanks Valves and write us for Catalog No. 21.

Fig. 0302
150 lbs. Steam Pressure

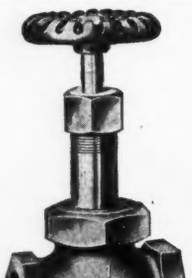


Fig. U-01
150 lbs. Steam Pressure

Fig. 0616
150 lbs. Steam Pressure

## THE FAIRBANKS COMPANY

*Valves, Dart Unions, Hand Trucks and Wheelbarrows*

**397 Lafayette St.** **New York, N. Y.**

Boston, Pittsburgh—Distributors in Principal Cities
Factories: Binghamton, N. Y., Rome, Ga.

**Fairbanks** *Standard and* Renewable **Valves**


(9) greater refractory thickness in front of any supporting metal; (10) horizontal box supporting castings provide for lateral thrust without excessive weight; (11) horizontal box supports are spaced away from heated refractories, preventing overheating and permitting insulation of hotter walls; (12) as much as 1½-in. of insulation placed between refractories and box supports, preventing possibility of metal growth and the consequent opening of joints between refractories; (13) expanded metal lath and hard finish coat conceals all castings and gives neater finished appearance. Also eliminates dust-catching projections; and (14) venting concealed box casting prevents overheating under severe operating conditions.

*Geo P Reintjes Co, 2517 Jefferson St, Kansas City, Mo.*

## Vacuum Cleaner

TORNADO industrial cleaner is noiseless, and weighs about 60 lb. One-hp motor is direct-connected with series of fans giving air displacement of over 175 cfm. Filter

area and storage space for dust holds 7½ gals., and can be wheeled away when full. Filter may also be removed for cleaning.

*Breuer Electric Mfg Co, 5100 N Ravenswood Ave, Chicago, Ill.*

## Distributing Fitting

POSITIVE fitting provides adjustable water volume control for individual radiators on single-pipe, booster-pump, hot-water heating jobs. Consists of brass casting in which friction-grip baffle plate is mounted. Adjustment is made by releasing set screw and turning adjusting cap which sets baffle in any desired position.

*Sullivan Valve & Engineering Co, 910 South Arizona St, Butte, Montana*

## Waterproofing Cement

FLEXSEAL is similar to airplane waterproofing, but has been changed to give better bonding on concrete, brick or stone. Made of nitro-cellulose, lacquer, oils and solvent. Solution may be applied by even an inexperienced worker, as only knowledge needed is how to swing a brush.

*Flexrock Co, 23rd & Manning Sts, Philadelphia, Pa.*

# YOU NEED INVEST ONLY $98.00 THE SIMPLE CASH STANDARD WAY TO GET A START ON THE MANY BENEFITS OF AUTOMATIC COMBUSTION CONTROL

**To begin with, you pay $98.00 — that is all — for the Furnace Draft Controller which you install first with the thought that later on, when you are ready, you can add enough additional units to have a complete CASH STANDARD Automatic Combustion Control System. This purchase plan, which is being used and appreciated by many companies, saves the need of a large initial investment.**

**The way you can prove that this equipment is tops in quality and in performance is to try it—and it only costs $98.00 to start, yet you get the immediate benefits.**

**These control units are precisely the same as those we furnish on the most elaborate jobs—and for the largest kind of boilers. To make this plan workable, the simple requirement is that the control units be installed conveniently near the apparatus they operate without panel board.**

**You get a Fuel Feed Controller, Air Flow Controller, each with an Operating Power Cylinder and some simple connecting fittings—all for as little as $300.00. If you want CASH STANDARD Control Systems on panel boards, you can get them but we emphasize that the control units work just as well mounted individually elsewhere.**

## FURNACE DRAFT CONTROLLER — A

**This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper, to maintain a constant draft in the combustion chamber. Place it near the uptake damper. It works independently of either of the two Controllers B and C shown in illustration. It does its part toward money-saving by eliminating wasteful air infiltration.**

## FUEL FEED CONTROLLER — B

**This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.**

## AIR FLOW CONTROLLER — C

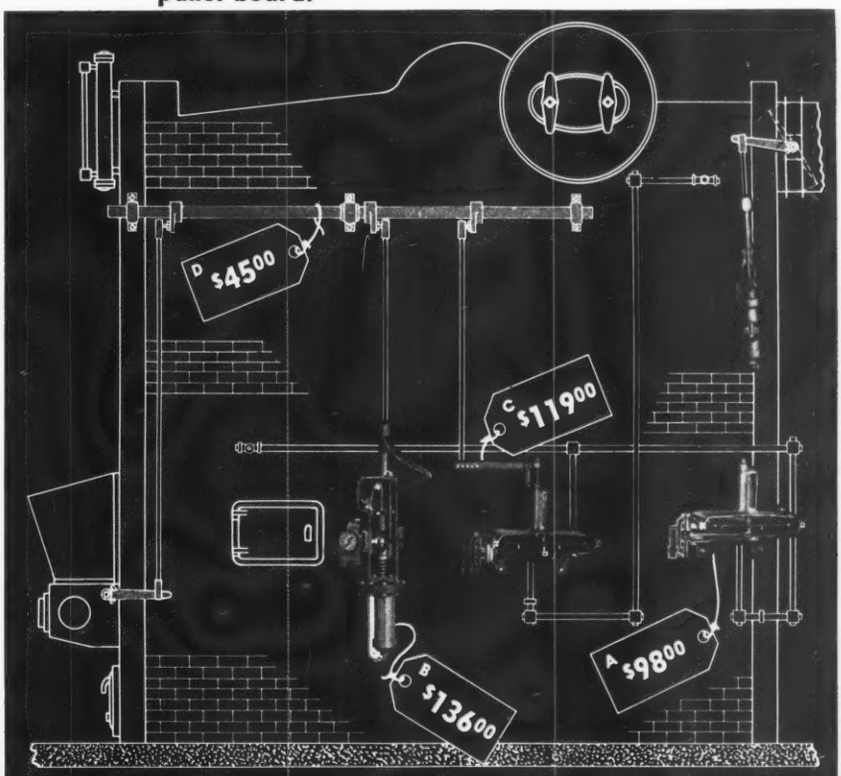
**This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.**

## OIL CIRCULATOR

**All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate this equipment with this CASH STANDARD Oil Circulator. Price $108.00 when equipped with 110-220 v. single phase 60 cy. motor.**

***SEND FOR FULL DETAILS.***

**There'll be no obligation on your part should you want to find out more about CASH STANDARD Automatic Combustion Control. In one case Automatic Combustion Control enabled a company to use coal costing only $1.35 a ton, helping to cut fuel bill by 30%. Let us send you the important facts — see how you can benefit through this modern plan and through the modern CASH STANDARD System that will give you the means to have a more profitably operating boiler room.**




**First you buy**

(a) Type 90 Furnace Draft Controller with Operating Power Cylinder, and Ball and Socket Joint $ 98.00

**Then you add the rest of the system. The typical units shown in the diagram would cost you**

(b) Type 100-W Fuel Feed Controller with Operating Power Cylinder and Ball and Socket Joint ..... $136.00

(c) Type 95 Air Flow Controller with Operating Power Cylinder and Ball and Socket Joint ..... 119.00

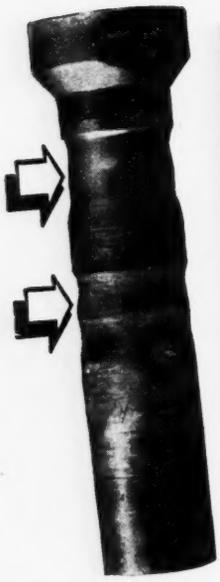
(d) Typical Jack Shaft, Levers, and Ball and Socket Joints ..... 45.00

$300.00

**A. W. CASH COMPANY**
**DECATUR, ILLINOIS**

**CASH STANDARD CONTROLS . . VALVES**

ADVERTISING PAGES REMOVED

SAVE SHAFT METAL WORTH HUNDREDS OF DOLLARS PER POUND

The loss in weight of a shaft sleeve from wear may be measured in ounces. Without this metal, however, the entire shaft sleeve is only scrap. Hence the value of metal destroyed by packing friction takes on a price of hundreds of dollars per pound. PALCO PACKING prevents this wear on all water pump plungers and shafts and is especially recommended for high speed centrifugals. PALCO is self lubricating and effects a tight seal without creating undue friction. The perfect lubrication of PALCO reduces wear of the shaft and increases life of packing.

• •

*PALMETTO
for steam, air, hot fluids
*PALCO
for water
*PELRO
for solvents, oils
*CUTNO
for alkalis
*SUPER CUTNO
for acids
SUPER SHEAT
general all-purpose sheet

*Reg. U. S. Pat. Off.

FREE TEST SAMPLE

We will gladly send you free, a working sample. Note how soft and pliable it is. Use it. Be guided by the results.

GREENE, TWEED & CO.
Self-Lubricating & Sheet Packings
101 Park Ave. New York, N. Y.
Established 1863

PALCO
Reg. U. S. Pat. Off.
PACKING

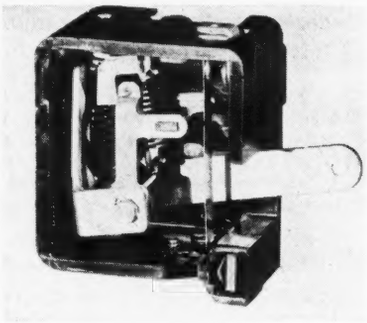

## Flashlight Extension

NOVEL FLASHLIGHT extension can be used to get light into small spaces not readily accessible by other lamps. It is made of special wire encased in aluminum alloy tubing. Its plug is screwed into any flashlight with bulb in opposite socket. Being bendable it can go around corners, and down into intricate mechanisms, etc. Available with tubing lengths from 6- to 36-in.

*Sierra Aircraft Co, Sierra Madre, Calif.*

## Float Switch

DESIGNED specifically for sump-pump control, switch is single-pole type employing overcenter toggle mechanism. Float-rod weight is counterbalanced by calibrated



spring acting on the operating lever. Other features of switch include corrosion resistant parts in mechanism which permit operation under severe moisture conditions, accessible terminals for easy wiring, and snap-action mechanism.

*General Electric Co, Schenectady, N. Y.*

## Gasket

COMBINES desirable properties of asbestos and Neoprene, according to maker, In process they are first blanked from asbestos sheet material, then coated with Neoprene cement developed to increase its resistance to passage of gases and liquids. These are used for light-pressure joints. When Neoprene-asbestos material is compressed further, a new material is formed. This is said to have greater strength and is used for higher-pressure joints.

*Victor Mfg & Gasket Co, Detroit, Mich.*

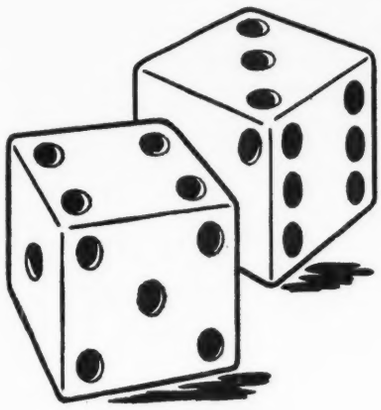
## Reaction Solder

METHOD of soldering said to eliminate iron tinning, fluxing and conventional solder bar. Consists of powder, which contains a combination of selected electro-positive metals, with chemicals, to form chemical reaction with metals which it joins. Reaction is fast, depending only on application of relatively low heats. Application: reaction solder is applied to joint, in powder or paste form and heat is applied. Said to work with ferrous and non-ferrous metals, such as iron, steel, stainless-steel, copper, bronze, nickels, tin, aluminum, aluminum alloys, Monel metal, brass and

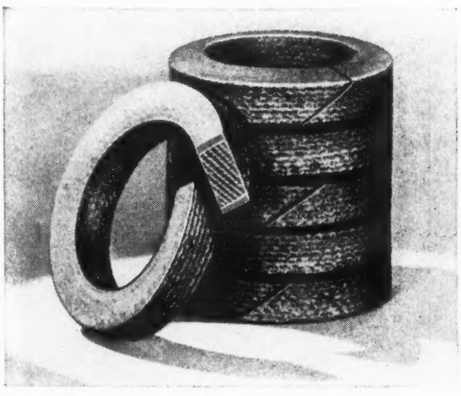
# 7-Come-11

## YOUR LUCKY NUMBERS

GARLOCK 711 Spiral



# Garlock 711



GARLOCK 712 Rings—cut from GARLOCK 711 Spiral and furnished to fit any rod and stuffing box dimensions.

"Seven—eleven!" These are lucky numbers to plant superintendents and engineers who know and use GARLOCK 711 Spiral Packing—a superior packing in every way.

GARLOCK 711 has unusual ability to adjust itself to operating conditions—expanding or contracting to conform with rods and plungers that are worn, out-of-line or subject to lateral motion. Constructed of closely woven duck, frictioned with a specially compounded rubber, it is recommended for service against medium and low pressure steam, hot or cold water and ammonia. Try GARLOCK 711 in your plant!

THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

# GARLOCK

- **Effective up to 1600° F.**
- **Low Conductivity**
- **Send for Sample and Complete Information**

Gone are the days when you required one type of insulating block for low temperatures and another block for high temperatures. BALDWIN-HILL MONO-BLOCK, fabricated of chemically stable black rockwool, covers the entire range up to 1600° F. with maximum efficiency at all temperatures. It is light in weight and easily cut and fitted to surfaces having irregular surfaces. B-H Mono-Block is made in lengths from 18″ to 36″, widths from 6″ to 12″ and thicknesses from 1″ to 4″. For an insulation problem you believe out of the ordinary, call in a Baldwin-Hill insulation engineer.

**B-H BOND-TITE**

Highly efficient adhesive used for holding block against surface being insulated during application. Also effective for sealing porous surfaces.

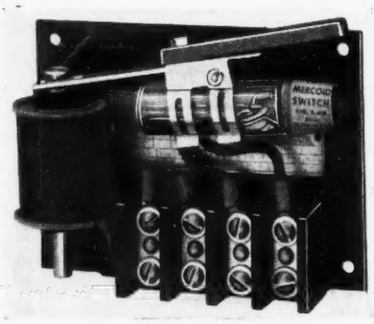
**BALDWIN-HILL CO.**
575 KLAGG AVE. . . . . TRENTON, N. J.


other metals. Resultant joints with the solder are said to be strong and not have any tendency toward electrolytic corrosion.

*Colonial Alloys Co, Colonial Philadelphia Bldg, Philadelphia, Pa.*

## Mercoid Relay

DESIGNED for panel mounting and recommended for control of motors, valves, electric heaters, etc, relay is said to be very simple in operation. Plunger-type solenoid actuates a tilting arm to which the Mercoid mercury contact switch is attached. When coil is energized, plunger floats within the plunger guide tube. Opening of solenoid pilot circuit or current failure causes plunger to drop by gravity. Hermetically-sealed mercury contact switch is said to be immune to pitting, oxidation or corrosion. Unit is available for any voltage or cycle between 6 volts and 230 volts ac or dc.




*Mercoid Corp, 4203 Belmont Ave, Chicago, Ill.*

## Fire Extinguisher Wall Bracket

WALL BRACKET protects extinguishers from swinging against or scratching walls, and from being knocked off a wall, with resulting damage to extinguisher or discharge of contents. Has long steel band at back extending the length of the extinguisher, and provides 2-point suspension. At top it slides into supporting loop on extinguisher. At bottom a semi-circular holder fits around the apron of the extinguisher to prevent sidesway.

*Pyrene Mfg Co, 560 Belmont Ave, Newark, N. Y.*

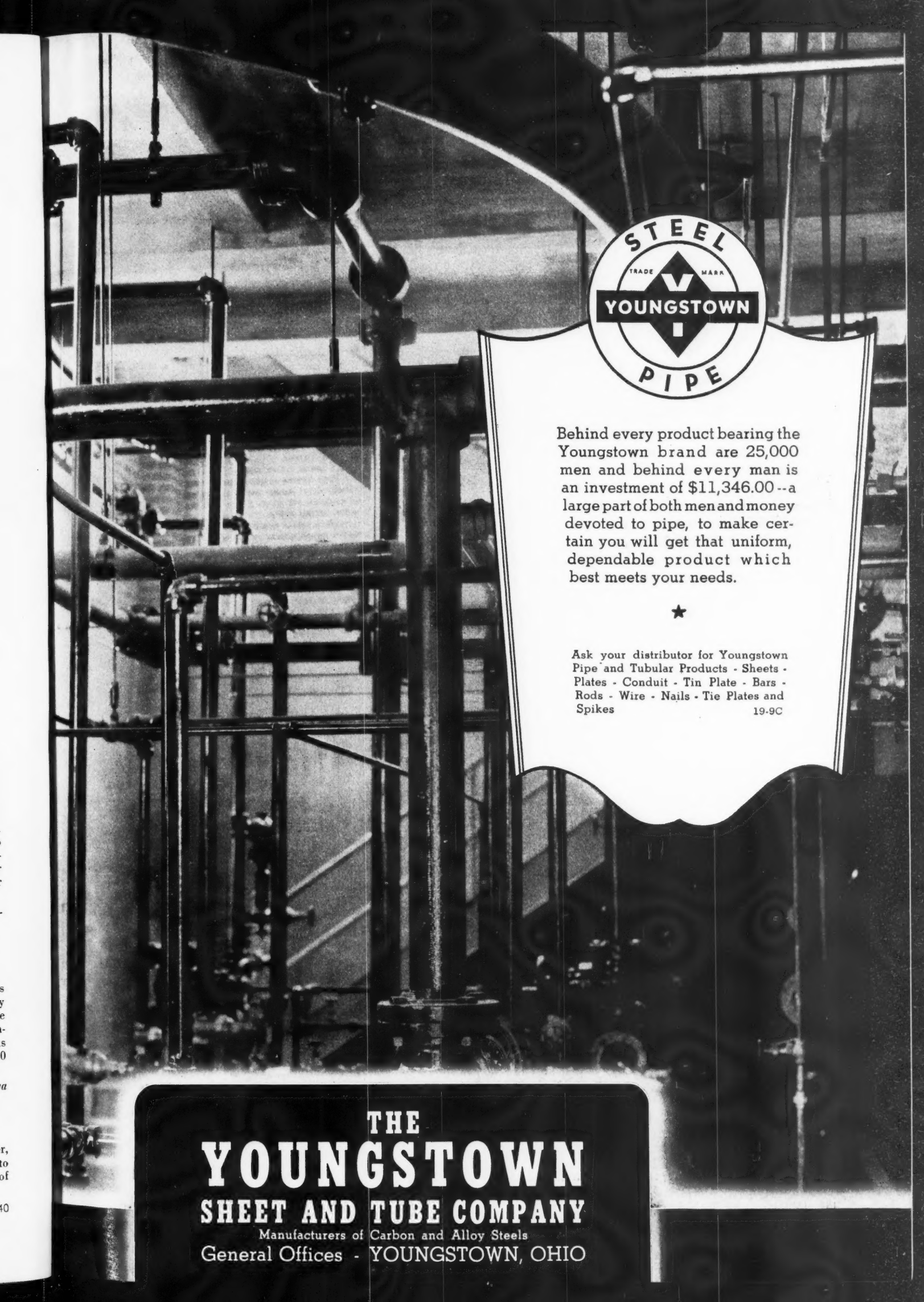
## Reducing Valve

PILOT-OPERATED pressure-reducing valve is smaller and more compact than ordinary pilot-operated valve, says maker. Type 92 is equipped with removable pilot strainer separate from the valve body. All parts of valve accessible for inspection, and 10 sizes available in range from ¼ to 6 in.

*Fisher Governor Co, Marshalltown, Iowa*

## Valves

"HYDRA" valves may be used on water, steam, and oil lines, at pressures up to 4000 lb per sq in. One-eighth turn of

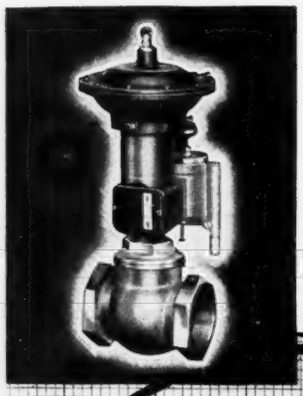

STEEL
TRADE MARK
YOUNGSTOWN
PIPE
Behind every product bearing the Youngstown brand are 25,000 men and behind every man is an investment of $11,346.00--a large part of both men and money devoted to pipe, to make certain you will get that uniform, dependable product which best meets your needs.
★
Ask your distributor for Youngstown Pipe and Tubular Products - Sheets - Plates - Conduit - Tin Plate - Bars - Rods - Wire - Nails - Tie Plates and Spikes
19-9C
THE
YOUNGSTOWN
SHEET AND TUBE COMPANY
Manufacturers of Carbon and Alloy Steels
General Offices - YOUNGSTOWN, OHIO

GRADUAL CONTROL IS G-R-A-D-U-A-L

When JOHNSON "Streamline"* VALVES ARE USED

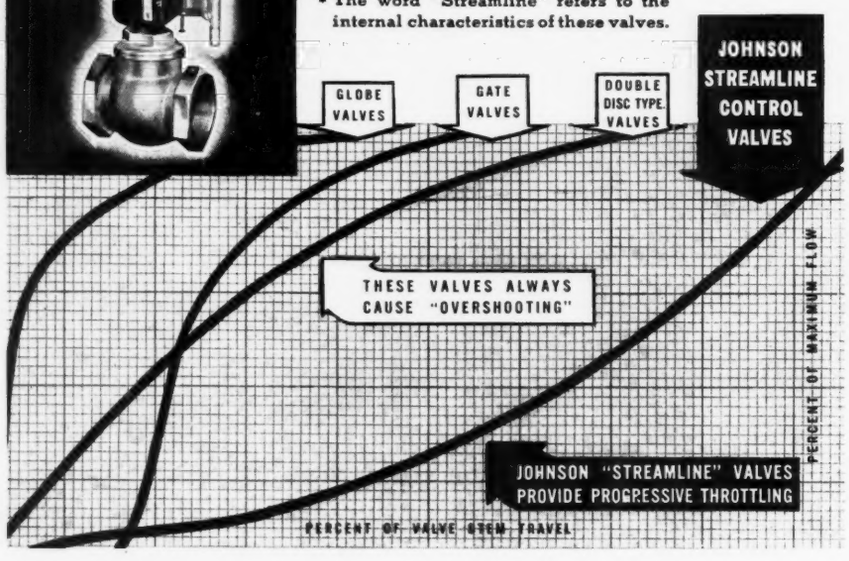
ABOVE—*Modulating valve with "Sylphon" metal diaphragm.*

BELOW—*Pilot-operated modulating valve with rubber diaphragm.*



THE partial chart below indicates the impressive advantages of Johnson "Streamline" Control Valves. Since their introduction, several years ago, long-sought gradual action, denied by other types of valves, has been possible. The Johnson "Streamline" is more than just another valve with disc and seat of special design. Beyond that, the construction of the entire unit is such that perfect throttling control is produced. Note the distinctive characteristics shown by the curve. With Johnson "Streamline" valves, the percentage of steam flow does not "jump ahead" of the valve stem travel. No overshooting! True gradual action!

* The word "Streamline" refers to the internal characteristics of these valves.


GLOBE VALVES
GATE VALVES
DOUBLE DISC TYPE VALVES
JOHNSON STREAMLINE CONTROL VALVES
THESE VALVES ALWAYS CAUSE "OVERSHOOTING"
JOHNSON "STREAMLINE" VALVES PROVIDE PROGRESSIVE THROTTLING
PERCENT OF MAXIMUM FLOW
PERCENT OF VALVE STEM TRAVEL

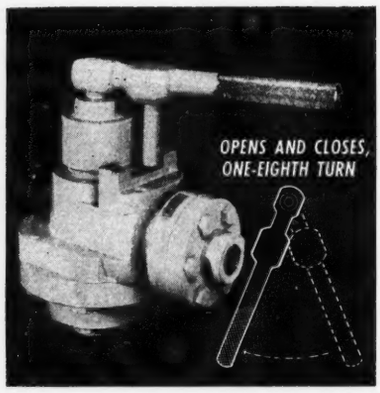
Johnson "Streamline" valves are available with "Sylphon" seamless metal bellows or with enclosed and protected diaphragms of super-aged and heat resistant rubber. Rubber diaphragm "Streamline" valves are fitted, as an optional feature, with Johnson's ingenious pilot mechanism.

Smooth gradual operation, independent of variation in friction and pressure. Pilot-operated "Streamline" valves, controlled by Johnson "adjustable sensitivity" instruments, represent the ultimate in superior GRADUAL CONTROL. Ask for descriptive Bulletins.

JOHNSON

Automatic TEMPERATURE AND AIR CONDITIONING Control

JOHNSON SERVICE COMPANY, MILWAUKEE, WIS. & BRANCHES IN PRINCIPAL CITIES


operating handle opens or closes valve. During this operation, four stainless-steel balls that close valve are automatically engaged into port holes due to pressure on the line. There are no valve seats to regrind, and consequently no need to remove valve from line. Internal parts are stainless steel. Valves are operated by hand or by electric solenoids with push-button control.

*Albright Equipment Co, 939 Crafts Bldg, Pittsburgh, Pa.*

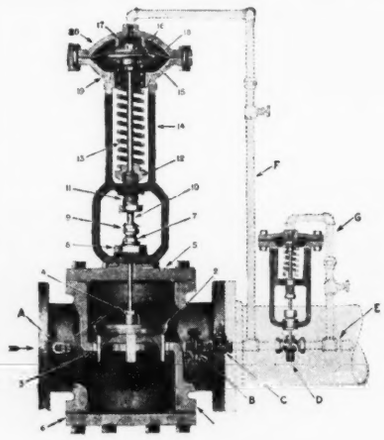
## Silica Remover

"SILIMITE" is special form of activated lime containing magnesia, said to be highly effective in removing silica in hot process softeners. Calcium content of lime is used in softening while other constituents are effective in silica removal. In plant operation, Silimite is slaked in accordance with definite procedure. Slaked Silimite and soda ash then are introduced into softener and operation is carried on in same manner as with normal softening. Silica removal is effective and low in cost, according to manufacturer, and there is no increase in alumina, sulphates or other dissolved solids.

*Allis-Chalmers Mfg Co, Milwaukee, Wis.*

## Pressure Regulator

SINGLE-SEATED reducing regulator is auxiliary-operated. In operation, main valve, when direct seated, is held open by spring tension and closed by inlet pressure on diaphragm. Pilot valve is installed in bleed-off connection of main valve dia-



# CLEAN...

## BETHLEHEM PIPE

*Six separate operations clean Bethlehem Pipe both inside and out, so that it's really smooth. It reaches you in the same condition, too, because it's protected with colorless lacquer or quick-drying oil immediately after final hydraulic pressure-testing.*

*In sizes up to 3 inches, Bethlehem Pipe is now made by the* Continuous-Weld Process *for even greater cleanness and uniformity and is sold under the trade name* BETH-CO-WELD. BETH-CO-WELD *is furnished in uniform 21-foot lengths, plus or minus one inch.*

*Order Bethlehem Pipe from your distributor today. You'll find that it threads clean, too, and that it's strong and durable enough for years of faithful service.*

BETHLEHEM STEEL

## BETHLEHEM STEEL COMPANY

# IT GUIDES THE HAND THAT GUIDES THE DIESEL!!!!

Delicate adjustments producing efficient combustion and peak power, with resulting fuel and lubrication savings, cannot be made by guesswork. The hand that sets the controls of your four-cycle Diesels needs the guiding information which the Cities Service Heat Prover provides. This instrument continuously and instantaneously measures changes in the amount of oxygen and combustibles in exhaust gases.

We have numerous examples in our files where savings in lubricant costs followed a demonstration of the Cities Service Heat Prover by Cities Service Lubrication Engineers. Our lubrication engineers will be glad to demonstrate the instrument in your plant. No plant is too large nor too small to benefit by the use of the Heat Prover.

They also will show you how Cities Service "Service Proved" Diesel lubricants work with the Heat Prover to protect against excessive wear and to assure an efficiently clean engine. Cities Service Diesel lubricants have won the title "Service Proved" by their years of constant, reliable service to the Power generating industry.

Send in the attached coupon. A copy of our booklet "Diesel Engine Lubrication" will be sent free to owners of Diesel power plants.

CITIES SERVICE DIESEL LUBRICANTS

**CITIES SERVICE OIL COMPANY**
**Room 1326 P**
**Sixty Wall Tower, New York**

Please have your Lubrication Engineers call and tell me how I can secure Heat Prover Service. .....( )

Please send me a copy of the Booklet "Diesel Engine Lubrication" .....( )

Name .....

Firm Name .....

Firm Address .....

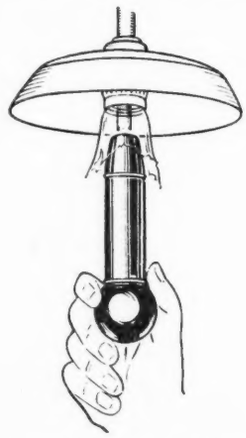
City ..... State.....


phragm, with a line from reduced-pressure side connected to pilot valve diaphragm. Slightest fluctuation in reduced pressure causes pilot valve to open, thus varying pressure on main valve diaphragm, and in turn, maintaining set pressure.

*McAlear Mfg Co, Chicago, Ill.*

## Lamp-Base Remover

FOLLOWING SHATTERING of light bulbs in sockets, base remains, and it is sometimes difficult and dangerous to remove. Attachment is inserted into broken base and unscrewed. May be used with current on or off, says maker. Unit comes in two sizes, for standard or Mogul base.



*Ericson Mfg Co, 5716 Euclid Ave, Cleveland, Ohio*

## Traps

Two new traps supersede small Series 200 formerly made. Features of new traps include more rugged construction, with more metal added at connecting points and around water passages; freer flow of water due to redesigned cross-section of water passages; one-piece stainless-steel bucket, with single casting size for both ½- and ¾-in. pipe connections. Both new traps have inverted-bucket operating principle, free-floating valve mechanisms, self-scrubbing action, heat-treated valve seats.

*Armstrong Machine Works, Three Rivers, Mich.*

## Motors

VERTICAL, single-phase motors announced in sizes from ¾- to 5-hp. Solid or hollow shaft modifications can be furnished. Operating speeds are 1200, 1800 and 3600 rpm. All 1800 and lower speed motors are built as repulsion-start induction-run motors, which start as repulsion motors with two brushes shorted. At a predetermined speed a centrifugal device shorts the entire commutator, allowing the motor to come up to speed and operate as an induction motor. The 3600-rpm ratings differ in that they do not require a short-circuiting device in armature. These start as repulsion motors, and as speed increases deeply-imbedded squirrel-cage winding in rotor picks up most of the load.

*Fairbanks, Morse & Co, 600 S Michigan Ave, Chicago, Ill.*

# ENDURANCE RECORD OF NEW CHASE ALLOY:

# *OVER 4,000,000 POUNDS of ANTIMONIAL ADMIRALTY*

## Without One Report of Tube Failure from Dezincification

● It is now possible for power plants to reduce failures of condenser tubes caused by dezincification. Over 4,000,000 pounds of Chase "Antimonial Admiralty" have been sold for condensers, heat-exchangers, and evaporators without one report of tube failure from dezincification.

Chase Antimonial Admiralty, the patented, new alloy, offers all the advantages of both ordinary Admiralty Metal and Red Brass, yet costs no more than either. It resists dezincification, which is one of the most prevalent types of corrosion. Red Brass has overcome dezincification, but in some cases it has failed from impingement. Chase "Antimonial Admiralty" is more resistant to dezincification than plain Admiralty, and while not totally resistant to impingement, it is more resistant than Red Brass.

The wide experience of Chase Metallurgical Engineers is at your call. Many are finding this consulting service helpful in solving operating difficulties. We may be able to help you, too.

**CHASE BRASS & COPPER CO., *Incorporated***
Subsidiary of Kennecott Copper Corporation
WATERBURY CONNECTICUT

**A PATENTED ALLOY**
**The formula for Chase Antimonial Admiralty is protected by U. S. Patent No. 2,061,931**

*Chase research keeps pace with industry's changing needs for new and better alloys. Let Chase engineers apply the results of this continuous research to your operating problems.*

**CHASE CONDENSER TUBES**

**The SCAIFE Man is a good man to consult when boiler water is your problem! Use his broad experience in determining the most practical and economical means of conditioning *your* feed water—for *safe operation, higher efficiency, lower maintenance costs.***

FOUNDED SCAIFE 1802

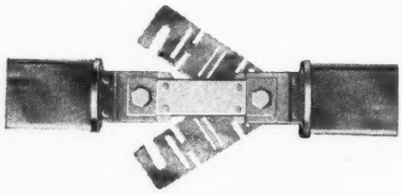
**WM. B. SCAIFE & SONS CO.**

**General Offices, Laboratory and Works—OAKMONT, PA. (Pittsburgh District)**

**Representatives in Principal Cities**


## Fuses

"HI-LAG" fuses have higher lag on starting loads, according to statement by maker. Also has one-piece link, spring-tension contact, and simplified construction. Double-bridge assembly easier to renew than over-



load, says maker. One end of casing is removed to renew fuse, and assembly may be inserted either end first. Link is said not to develop high resistance, and will expand without sharp bending.

*Ware Brothers, 4500 W Lake Street, Chicago, Ill.*

## Worm Speed Reducer

LINE is newest to be manufactured by company, with ratios ranging from 4 5/6 to 1 to 100 to 1, and input capacities of from ¼ to 2 hp at 1800 rpm, and ⅛ to 1½ hp at 1200 rpm. Gears, wheel and worm are assembled in semi-steel, oil-tight housing with bearing supports for both worm and worm wheel machined in one casting, eliminating split bearings and shims.

*Abart Gear & Machine Co, 4832 W 16th St, Chicago, Ill.*

## Relay Tool Kit

COMPLETE KIT for setting and maintaining Westinghouse relays consists of steel tool box containing conventional and special tools found useful in maintenance of relays. In addition to complete set of pliers, wrenches and screw drivers, the kit contains a dental mirror, thickness gage, set of spring adjusters, set of contact and needle files, and cleaning materials.

*Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.*

## Repair Plug

"MULTI-SEAL" repair plug is rivet which can be applied by one man from one side of the work. It consists of special steel bolt surrounded by jacket of ductile metal. Jacket has square head at one end, over which are placed a washer and a nut. To use plug, hole is drilled or reamed at place to be plugged. Repair plug is inserted and tightened with two ordinary wrenches, one holding the ductile head and the other tightening nut on the bolt. Tightening action first squeezes ductile metal into a rivet head inside the hole, second, expands that metal within the hole, filling it completely, and third, compresses that metal shoulder against outside of the hole, forming a triple-seal.

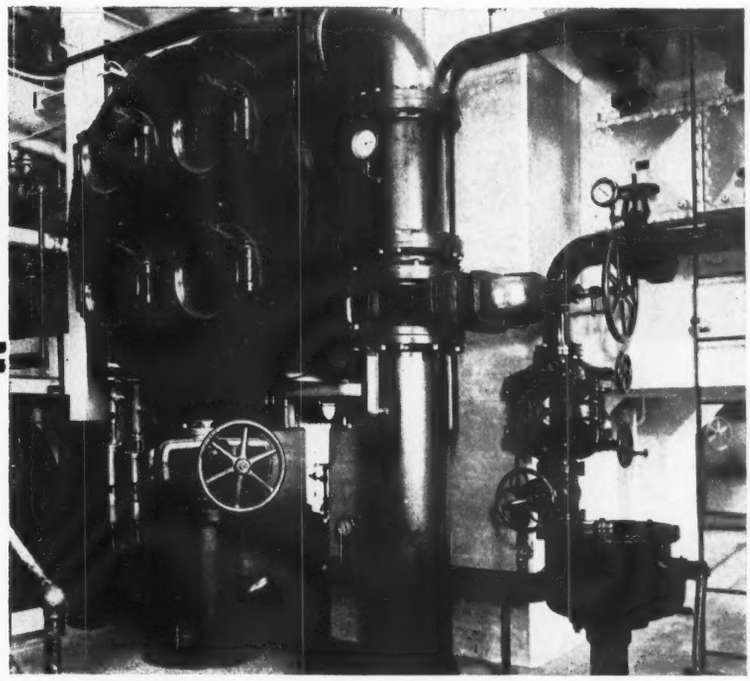
*Rolyan Corp, 2241 Indiana Ave, Chicago, Ill.*

# PIPING

FOR CENTRAL STATIONS
INDUSTRIAL POWER PLANTS
AND PROCESS PLANTS

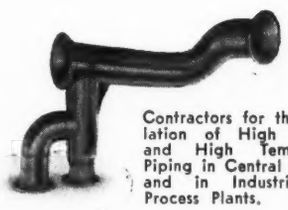
# INSTALLED

*by Skilled Workmen under Experienced Supervision*



Speed with care . . . when skilled pipe installation crews can offer that combination, particularly in connection with high pressure and high temperature piping, then you can sleep nights. The work will be done on time and will be done properly.

If you have a pipe installation job coming up, you will be interested in learning what we have done in central stations, industrial power plants, and process plants.



Contractors for the installation of High Pressure and High Temperature Piping in Central Stations, and in Industrial and Process Plants.

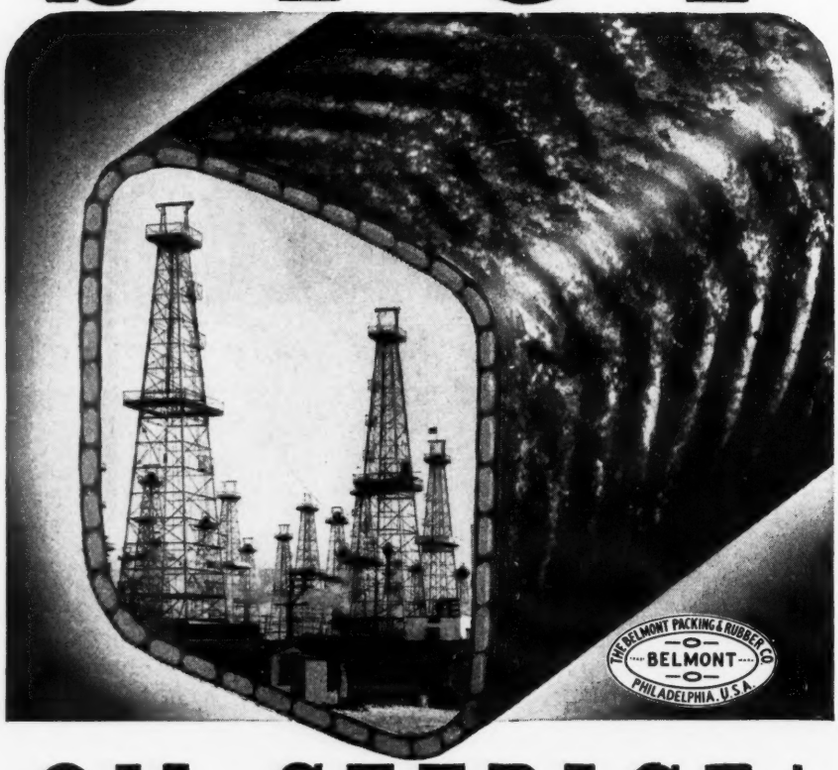
**UNDERGROUND STEAM CONSTRUCTION COMPANY**

*Subsidiary of*

## E. B. BADGER & SONS CO.

75 PITTS STREET BOSTON, MASS.

# STOP




# OIL SEEPAGE!

## *PACK WITH BELMONT*

End that drip drip drip! It's a profit eater —a fire hazard—exposes all your operations to possible loss.

Belmont 6100, illustrated above, is especially designed for use on rods and valve stems handling volatile distillates. Gasoline, naphtha, kerosene and benzol tend to break down ordinary lubricants. But Belmont 6100 uses a *special* lubricant (our exclusive formula) that keeps it soft, retains its sealing qualities longer. The fact that many of the largest refineries use Belmont 6100 is proof that it does the job better.

6100 is just one item in the complete line of Belmont oil packings built to give maximum performance in all types of oil service. Belmont also makes packings for other services. And each Belmont Packing is constructed for ultimate wear and greater efficiency.

The complete line of Belmont Packings (for all types of services) is described in detail in the new FREE 1940 Catalog. Write for it on your company letterhead today!

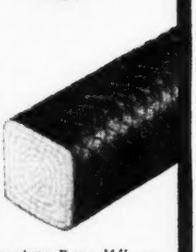
**Suggested Belmont Packings For Oil Service**

**BELMONT 6100**

Gasoline Packing Made of high grade asbestos yarn, braided jacket over jacket. Special lubricating compound keeps packing soft and retains sealing qualities even when applied to volatile distillates Square cross section. Available in 1, 3 and 5 lb. spools and in sizes from ⅛" to ⅜"

**BELMONT 189**

Hot Oil Asbestos Packing. Long fibre asbestos yarn, braided jacket over jacket. Oil penetration and saturation minimized by a special formula lubricant. Designed for use on either hot or cold oil rods and plungers Square cross section Supplied in packing space sizes from ⅛" up



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# BELMONT

PACKINGS

THE BELMONT PACKING & RUBBER COMPANY

BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.


# Power Lines

## Second 80,000-kw Unit for Port Washington

Work on a $7,000,000 addition to the Port Washington Station of the Wisconsin Electric Power Co will be undertaken at once, according to an announcement made late in July by president S B Way. Work on the plant will be rushed so it will be in operation by 1943, or earlier, if required.

Plans call for a second 80,000-kw turbine-generator to operate at a throttle pressure of 1250 lb and a temperature of 850 F. The generator will be an 1800-rpm, hydrogen-cooled machine, similar in most respects to the existing unit, which, however, is air cooled. A 600,000-lb-per-hr boiler will be installed to supply the new turbine.

## Grease Standards

The following is printed as a service to POWER readers at the suggestion of The National Lubricating Grease Institute.

"The National Lubricating Grease Institute at its annual convention in Chicago in 1939 adopted a classification for lubricating greases which it has copyrighted. This classification gives the grade numbers and the ASTM worked penetration for each grade. While this classification is in no way a standard or specification of quality. it establishes the body or consistency of the grease and assures the manufacturers and consumers of lubricating greases of securing uniform bodies or consistencies while using this classification."

## ASME Fall Meeting

The American Society of Mechanical Engineers will hold its 1940 Fall Meeting in Spokane, Wash., Sept. 3-6, with headquarters at the Davenport Hotel.

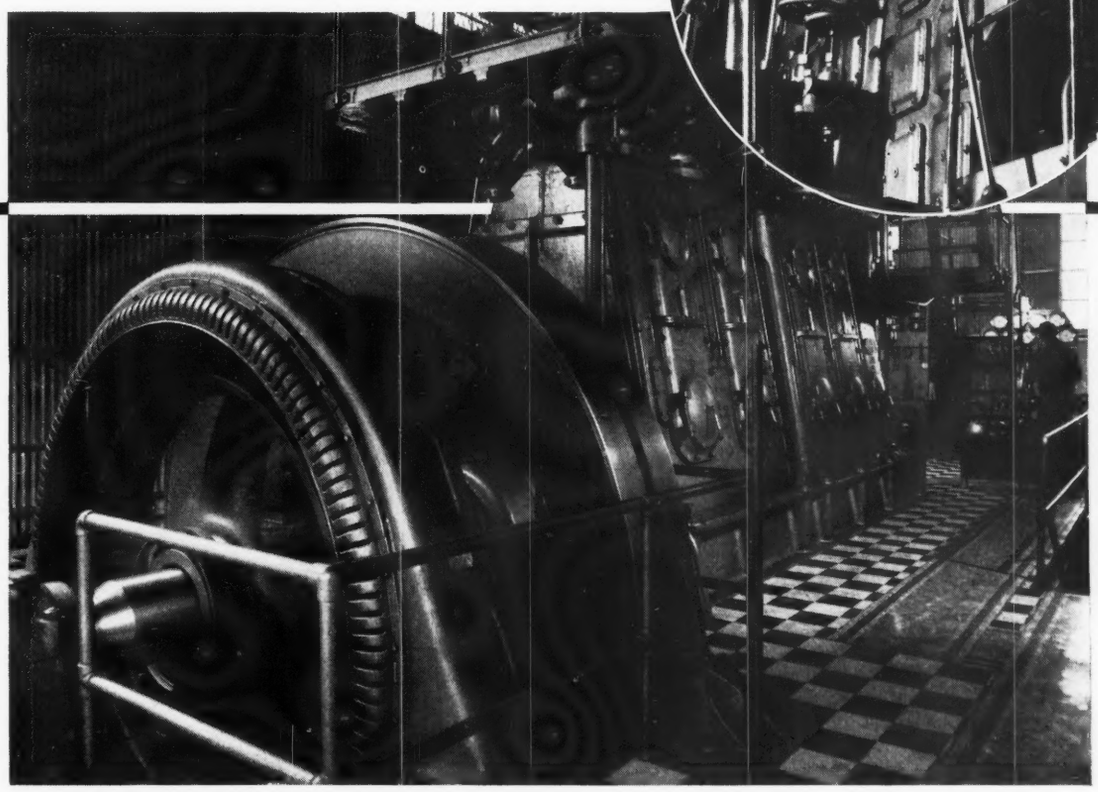
Twenty-eight papers are scheduled for presentation at the 13 simultaneous technical sessions to be held on Tuesday, Sept. 3, and Thursday, Sept. 5. Twelve of the papers will cover the design, construction, mechanical equipment, and potential uses of the Grand Coulee Dam, world's largest masonry structure. Other subjects to be discussed in the remaining papers include hydraulic problems, deepwell pumps, woodworking, coal, kiln drying, wood-waste utilization, and material handling in the lumber industry.

## Engineers Discuss Coal Applications

Nearly 400 persons from 20 states attended the 26th Appalachian Coals, Inc, fuel engineering conference late in June at the Shoreham Hotel, Washington, D. C. The program was planned by J E Tobey, vice president in charge of engineering for Appalachian Coals, Inc., the sponsoring organization, and the A C I staffs at Cincinnati, Ohio, and Knoxville, Tenn.

Louis A Johnson, Assistant Secretary of

# "GULF PARVIS OIL *has helped us avoid liner replacements for many years"* ... says Chief Engineer



## *"Our four Diesels are making splendid records of ECONOMICAL TROUBLE-FREE OPERATION"*

● "We're convinced that GULF PARVIS OIL is the ideal lubricant for our four big Diesels," says this Chief Engineer. "I have not seen nor heard of any report on Diesel operation that beats our record on liner replacements. The fine service we get from this high quality lubricant keeps our maintenance costs at a level even below expectations."

Here's one important reason why you can expect better results from Gulf Parvis Oil. This quality oil has been especially refined to withstand high temperatures, contamination with fuel and moisture, and constant churning in the presence of air. *More than 50 leading Diesel engine builders* have approved Gulf Parvis Oil for the lubrication of engines they build.

GULF PERIODIC CONSULTATION SERVICE is available to you no matter where your plant is located—in 30 states from Maine to New Mexico. Write or phone your nearest Gulf office today.

GULF INDUSTRIAL LUBRICATION

This booklet will suggest to you a practical method by which you can improve lubrication and reduce operating costs. Write for your free copy.

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3813 Gulf Bldg., Pittsburgh, Pa. .P.
Please send me my copy — no charge — of the booklet "GULF PERIODIC CONSULTATION SERVICE."

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Company.....

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# NO CARRYING OVER WITH THE STEAM!

"The Entirely Different Boiler and Engine Treatment"

Never — when Sand-Banum is used. That is why so many plants in process industries, packers and breweries are among the many hundreds of satisfied Sand-Banum users.

Scale does NOT form in a Sand-Banum treated boiler — and Sand-Banum also removes old scale with absolute safety.

Let us tell you how *ounces* of guaranteed Sand-Banum applied but once a week solve scale and corrosion problems. Complete details on request.

**AMERICAN SAND-BANUM COMPANY, Inc.**

**9 Rockefeller Plaza** **New York City**

WESTERN SAND-BANUM CO.

Houston, Texas *Agencies in Principal Cities* Fresno, Calif.

# COTTRELL PROCESS OF ELECTRICAL PRECIPITATION

**universally recognized as a standard method of removing**

**DUST, FLY ASH, FUME, MIST & FOG *from* GASES**

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**28 years of research development and operating experience by the affiliated Cottrell Companies throughout the world is incorporated in the**

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*associated with*

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1016 W. 9th St., Los Angeles


War and featured speaker at the Conference banquet, stated that security for America and American institutions is "in the hands of the coal industry". "Coal", said Johnson, "is indispensable to industry. Industry is indispensable to munitions. Munitions are indispensable to victory in battle".

Speaking as president of the National Coal Association, C C Dickinson said that "coal is one industry in the United States that had the initiative and brains" to devise a workable marketing plan, the regional sales agency pattern now in almost universal use in the various coal-producing regions of this country."

E G Bailey, vice-president of Babcock & Wilcox, told the conferees that nearly 90% of the larger steam boiler units purchased in the past year or two have been pulverized-coal fired. "Analysis of coal and its fusing temperature range", said Mr. Bailey, "are not truly representative of the important factors with which we have to deal in the furnace itself . . . When the factors are properly understood, we can accomplish some very worthwhile results by paying attention to the character of the ash and its behavior in response to different conditions."

Mr Bailey called attention to "woeful ignorance of the essential factors in the combustion of fuels" and the "lack of reliable and useful knowledge of coal itself and the ash which it contains". However, he also stated that this conference and the 25 meetings preceding it have added materially to the fund of coal technological information now available in the country.

Discussing "Research and Progress", Dr A A Potter, dean of engineering, Purdue University, said that "the coal industry can no longer afford to ignore research. "It is needed," he added "to reduce production and distribution costs of coal, to eliminate wastes, to develop new uses of this fuel, and to insure greater safety for the workers in the mines.

"Research and invention", Potter continued, "rather than governmental action, have absorbed in the past labor surplus and have elevated living standards by developing new materials, better processes, new industries, new utilities, more economical methods of manufacture, more efficient machines, improved products and additional markets.

"The coal industry can regain its place," he concluded, "or even play a more important role than ever before if it gives more attention to research, a fountain of youth for your industry and a practical aid in meeting the competition of the future."

According to T W Harris, Jr, division purchasing agent, E I duPont de Nemours & Co, whose paper "Maximum Buying Under Minimum Prices" was read by his assistant, W H Gehring, "difficulties in purchasing coal properly will be materially increased upon the application of minimum prices" by the bituminous coal division of the Department of the Interior. He listed certain "uncertainties" which will arise under minimum prices, referring to the "prices themselves", "quality", "production" and "uncertainties with regard to service."

Trends in industrial coal-burning were outlined by Philip W Swain, editor of

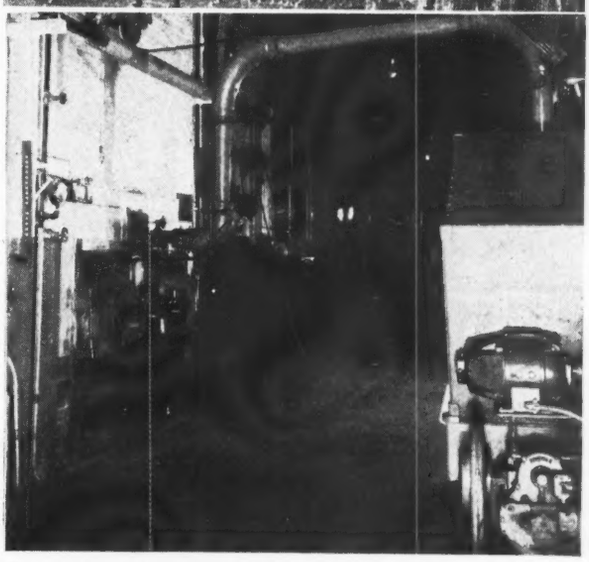
# Iron Fireman Spreader Stoker Saves 30%

## . . . and produces steadier steam for turbine generators in University of Alaska power plant

An Iron Fireman engineering survey showed the University of Alaska how to save money and assure a more reliable steam supply at uniform pressure. The survey revealed that a particularly low-cost supply of lignite, located near the University, could be utilized with Iron Fireman Spreader firing. On the basis of the survey, the University installed an Iron Fireman Pneumatic Spreader stoker.

Firing the lignite so efficiently that there is no smoke nuisance, Iron Fireman has cut fuel costs 30 per cent, reports President Charles E. Bunnell. Furthermore, this Iron Fireman Pneumatic Spreader stoker produces a steady, automatically regulated supply of steam, at uniform pressure, for the turbine plant, which generates electricity to take care of the institution's requirements.

The ability of the Iron Fireman Pneumatic Spreader stoker to retain a uniform steam pressure, in spite of wide fluctuations in demand, has greatly improved the University's heating, exhaust steam from the turbine generators being used for this purpose.



The power plant of the University of Alaska, with Iron Fireman Pneumatic Spreader stoker firing the boiler. Notice unobstructed firing aisle in front of the boiler. Pneumatic Spreader stokers are available in "Coal Flow" models, feeding direct from main bunker, or hopper models as shown above. Hopper may be placed within wide radius of boiler, or even on floor above or below the boiler. Top: President Charles E. Bunnell of the University of Alaska, whose campus in the Tanana Valley, the northermost university campus in the world, is shown above.

### Learn what YOU can save . . . Ask for engineering survey

Follow the lead of the University of Alaska and of thousands of other leading institutions and industries . . . authorize us to make an engineering survey of your boiler plant. This survey will determine, with engineering accuracy, your potential savings and betterments. We will make this survey at our own expense, and we invite the collaboration of your consulting engineer or plant engineer. You will be under no obligation.

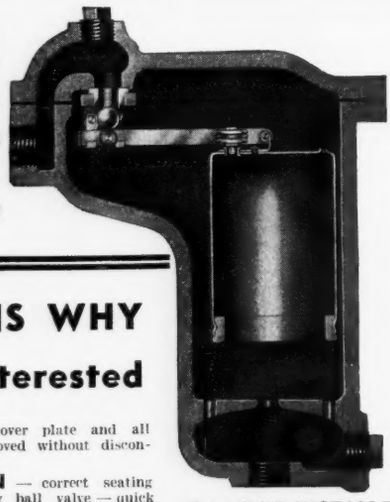
**IRON FIREMAN**
**Automatic Coal Stokers**

IRON FIREMAN MFG. CO., Portland, Ore.; Cleveland; Toronto.
*Mail to* 3378 West 106th Street, Cleveland, Ohio.
Please give us further information, without cost or obligation.

*Name*_____

*Address*_____

# CRYER STEAM TRAPS



• ACCESSIBLE
• POSITIVE
• QUICK VENTING
•

## 10 REASONS WHY you'll be interested

1 **ACCESSIBILITY** — cover plate and all mechanism may be removed without disconnecting any piping.

2 **POSITIVE ACTION** — correct seating insured by free turning ball valve — quick venting valve eliminates balancing and dribbling.

3 **QUICK VENTING** — rapid discharge of air without regard to temperature is assured by mechanically controlled quick venting valve.

4 **LARGE CAPACITY** — baffle plate prevents sudden surges from lifting bucket and closing valve — quick venting speeds action — large orifice in valve seat.

5 **LOW MAINTENANCE** — stainless steel wearing parts — ball valve free turning distributes wear — valve seat easily removed — cleaning is simple through test and drain outlets.

6 **EASILY INSTALLED** — inlet connections made through bottom or side — no special supports required.

7 **WILL NOT AIR BIND** — all air discharged before condensate through valve at top of trap.

8 **INTERCHANGEABILITY** — parts individually serviced.

9 **COST** — quickly repaid in savings and higher efficiency.

10 **GUARANTEE** — will discharge condensate at rated capacities — will operate satisfactorily within limits of pressure and capacity.

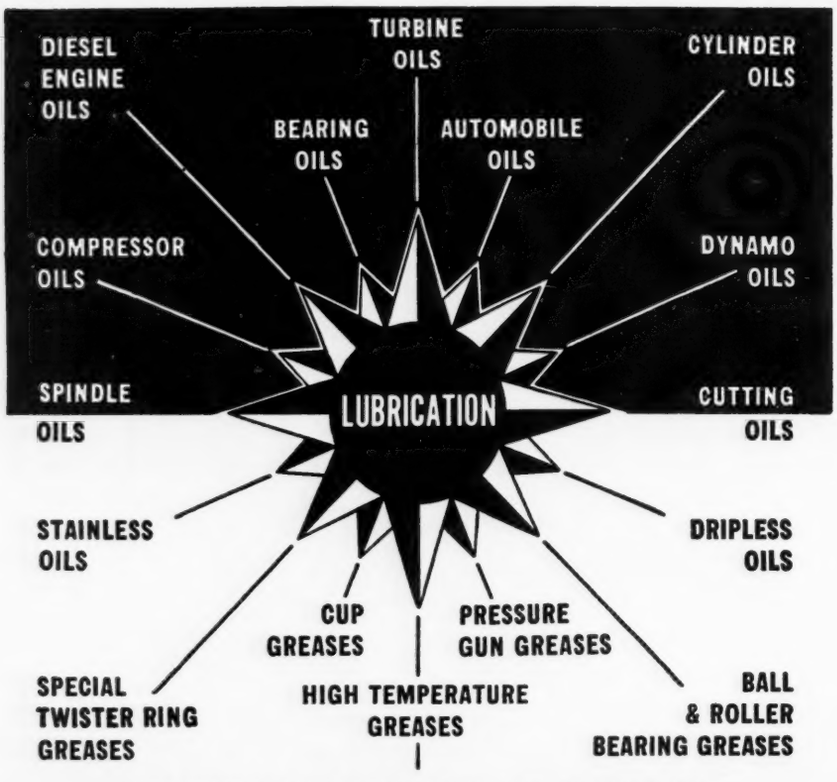
***Write for complete details of sizes, capacities available and prices.***

**CRYER TRAP & VALVE CO., INC.**

*Manufacturers of Steam Specialties for more than 40 years.*

**366 Madison Ave., New York, N. Y.**






**PRODUCERS of HIGH GRADE LUBRICANTS SINCE 1874**

**BORNE SCRYMSER COMPANY**

17 BATTERY PLACE • NEW YORK


POWER. "Equipment designers have been on the job right through the depression," he said. "As a result, fuel-burning equipment far finer in every way than formerly available is ready to meet the expected needs of American industry in this hour of preparation for defense."

"Status of Knowledge on the Properties of Coal Ash", a paper by P Nicholls, supervising engineer, fuels section, and W T Reid, associate fuel engineer, both of U. S. Bureau of Mines, Pittsburgh, Pa., concluded the formal program. Mr. Nicholls summarized the results of an elaborate research relating the fusion properties of ash and slag to its chemical composition. Discussion of this paper was led by Dr. A C Fieldner, chief, technologic branch, U. S. Bureau of Mines, Washington, D. C. J F Barkley, U. S. Bureau of Mines, also participated in the discussion.

## OBITUARIES

MAURICE ECKLEY MUTCHLER, 51, general sales manager of the Sterling Engine Co since 1920, died suddenly at his home, Kenmore, N. Y., July 22. Long a well-known figure in his field, Mr Mutchler had many friends in nation-wide boat, marine and yachting circles. He had been associated with the Sterling organization since 1913. Employed first in the Purchasing Dept, he soon became advertising manager and then sales manager.

JOHN LOWELL PIKE, 55, general superintendent of Allis-Chalmers Mfg Co's Electrical and Steam Turbine Shops at their West Allis Works since 1935, died suddenly at his home, July 24. After graduating from the Ohio State Engineering School, he started as a student apprentice at the Bullock Works in Cincinnati in 1905.

WILLIAM H QUINN, New York district manager of Chain Belt Co, died in New York recently. He had been with the company since 1923, and manager of the New York office since 1928. He attended Pennsylvania State College and during the World War served in France as a lieutenant in the infantry.

JOHN W IRVINE, 63, superintendent of Pittsburgh Piping & Equipment Co, Pittsburgh, Pa., died recently in Pittsburgh, as the result of a heart attack. Mr Irvine was one of the original employees of the company when it was founded 37 years ago. For the past 15 years he was superintendent of the company and previous to that was general foreman.

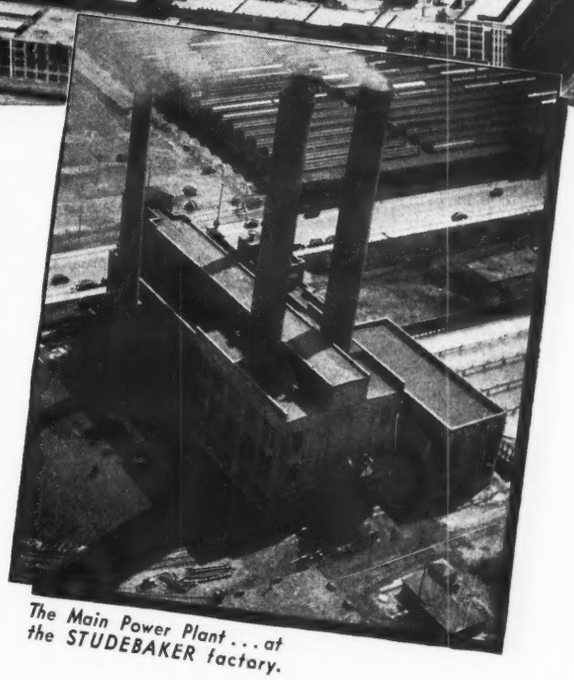
GEORGE L C BOURNE, 67, chairman of the board, Superheater Co, and Combustion Engrg Co, Inc, died early this summer. Mr Bourne was born in London, England, and entered this country in 1893, at the age of 20. He worked for a leading railroad for some time, and with some of his business associates formed the Superheater Co, of which he became vice-president. He held that position until 1932, when he became chairman of the board. In 1933 he was made chairman

*(Continued on page 170)*

# STUDEBAKER CHAMPIONS COAL!

*An Aerial View of THE STUDEBAKER CORPORATION factory, South Bend, Indiana—home of THE STUDEBAKER CHAMPION.*

## . . . the efficient, economical FUEL for *reliable* HEAT and POWER



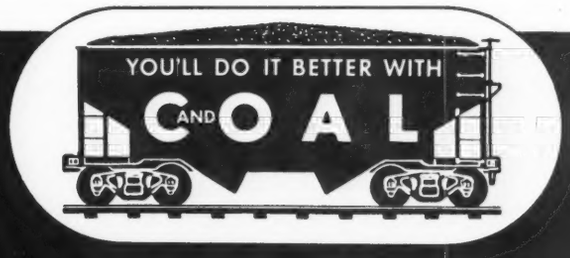
*The Main Power Plant . . . at the STUDEBAKER factory.*

● COAL has *always* been the choice of THE STUDEBAKER CORPORATION as the *dependable* source of heat and power for their huge manufacturing plants at South Bend, Indiana. STUDEBAKER shares this fuel preference with the majority of manufacturers in all branches of industry, where efficient production requires the modern, *dependable* fuel—COAL.

Over 95% of the coal burned in the Studebaker Power Plant came via Chesapeake and Ohio Railway from "The Coal Bin of America"—the country's richest deposits of bituminous coal.

You can write your own specifications for Chesapeake and Ohio coal . . . high or low volatile, B.T.U. rating, grindability, ash softening temperature . . . whatever you need, for somewhere along this railroad, in "The Coal Bin of America," are mines that can meet your most exacting requirements, and continue to meet them . . . just as this railroad can always be depended upon to deliver your coal on time and in perfect condition.

**For information or assistance with fuel problems, write GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio Lines, 2901 Terminal Tower, Cleveland, O.**




**CHESAPEAKE AND OHIO LINES**

ADVERTISING PAGES REMOVED


# ROTO Cleaners Can Help You Deliver MORE POWER for DEFENSE

Increased demands upon tubular equipment make operation at top efficiency a vital necessity. Cleaning tubes at regular intervals pays handsome dividends in extra power and lower fuel consumption.

The 1940 rapid-action Roto cleans tubes faster, better and for less money. Its tremendously increased power removes scale more quickly and thoroughly. A rapid-action "trigger" on the motor enables one man to operate the cleaner by himself. This eliminates a helper as well as signalling delays between each of the hundreds of tubes cleaned. There is a Roto for every size and shape of tube including the latest type curved tubes with sharp bends.

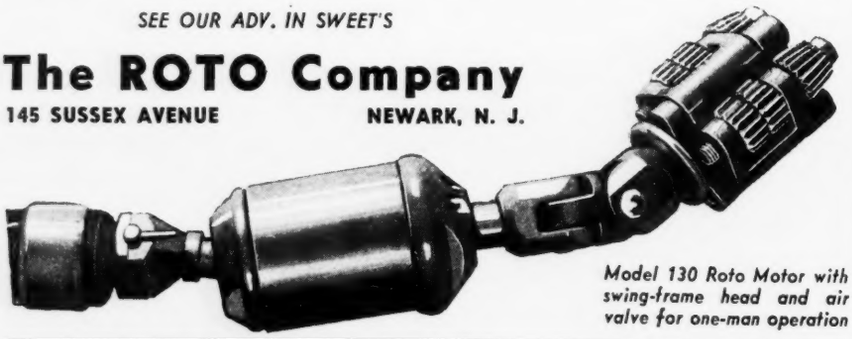
Now, more than ever, you owe it to yourself, your plant and your country to be ready with more power for defense. And Roto is ready to help you. Write.

## Only ROTO Cleaners Can Offer All These Features

- ★ make better use of available air, without back pressure;
- ★ develop unbelievable speed and power, through new design;
- ★ air valve directly behind the motor permits one-man operation and eliminates signalling delays;
- ★ self-feeding cage and swing-frame heads, universal joints and drills have what it takes to do a real job;
- ★ Available for straight and curved tubes ½" to 12" I.D.

*SEE OUR ADV. IN SWEET'S*

**The ROTO Company**
**145 SUSSEX AVENUE NEWARK, N. J.**



*Model 130 Roto Motor with swing-frame head and air valve for one-man operation*

# HERE'S HELP

**for technical and business men**

**NEW 1940 Catalogue of McGRAW-HILL BOOKS**

**OVER 1500 BOOKS DESCRIBED**

**Here is a guide to practical, expert information on many business and technical subjects. It contains clear, concise descriptions of more than 1500 authoritative, informative books written by leaders of business, industry and research.**

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**In it you will find the up-to-date books that will give you the facts—experience—data—you need in solving your particular problems.**

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# New Bulletins

### BOILERS AND ACCESSORIES

**1** STOKERS—Detroit Stoker Co., General Motors Bldg., Detroit, Mich. 12-page bulletin No. 550 covers complete line of Detroit stokers, including Unistoker, Lostoker, triple-retort stoker, Rotostoker, and multiple-retort stoker.

**2** DUST COLLECTORS — Pangborn Corp., Hagerstown, Md. 4-page mailing folder illustrates several applications of Pangborn dust collectors and lists companies who use them.

**3** DUST COLLECTORS — Prat-Daniel Corp, Port Chester, New York, 8-page catalog No. 108 covers Thermix tubular dust collectors. Practical advantages of design explained, construction details shown, and suggested layout with explanatory remarks presented. Brief listing of other types included.

**4** COAL PULVERIZERS — Whiting Corp, Harvey, Ill. 16-page bulletin No. 199 describes Whiting pulverizers, and tells how use of pulverizers will lower steam costs. Specifications, method of operation, and table of standard dimensions included.

### ELECTRICAL EQUIPMENT

**5** FUSES—Ware Brothers, 4500 W Lake St, Chicago, Ill. 8-page folder lists, illustrates and prices all types of Ware renewable, "Hi-lag" fuses. Advantages presented, together with ratings in amps and volts for each fuse.

**6** THERMOCOUPLES—Leeds & Northrup Co, Stenton Ave, Philadelphia, Pa. 40-page catalog N-33A(6) is described as first complete one on thermocouples published by company. Illustrations and listings arranged so that parts, accessories, and complete assemblies are easily available.

**7** PANELBOARDS—Westinghouse Electric & Mfg Co, East Pittsburgh, Pa. 4-page leaflet presents descriptions of Nofuze panelboards, with advantages and conveniences of several types. Several panel arrangements included.

**8** PANEL INSTRUMENTS — Roller-Smith Co, Bethlehem, Pa. 8-page Catalog No. 4120 covers 3- and 4-in. panel instruments. Current range and prices given for numerous models.

**9** INSULATED CABLE—General Electric Co, Schenectady, N. Y. 4-page bulletin No. GEA-2733D describes Flamenol insulated cable, giving conductors per conduit, and other general dimensions. Numerous typical applications of cable listed and illustrated.

**10** CONNECTORS—Burndy Engrg Co, Inc, 459 East 133rd St, New York, N. Y. 15-page booklet entitled, "Electrical Connectors Guide", is series of charts making simple the task of selecting proper connectors for given condition. Also gives brief advantages of various types of connectors.

**11** ELECTRICAL PRODUCTS—Colt's Patent Fire Arms Mfg Co, Hartford, Conn. Catalog No. 3 presents listing of entire line of Colt products, including safety switches, Multi-breakers, service equipment, fuses, etc, and listing of sizes "O" and "1" motor control units.

### AIR CONDITIONING & REFRIGERATION

**12** AIR CLEANER — American Air Filter Co, Inc, Louisville, Ky. 8-page bulletin 130-C describes American Cycoil oil-bath air cleaner, giving description of operation and installation instructions. Also covers other AAF products.

**13** AIR FILTER—Air-Maze Corp, 5200 Harvard Ave, Cleveland, Ohio. Form DH-640 gives models, capacities, dimensions and shipping weights of standard Air-Maze "DH" assemblies. Typical installations shown.

### MECHANICAL TRANSMISSION

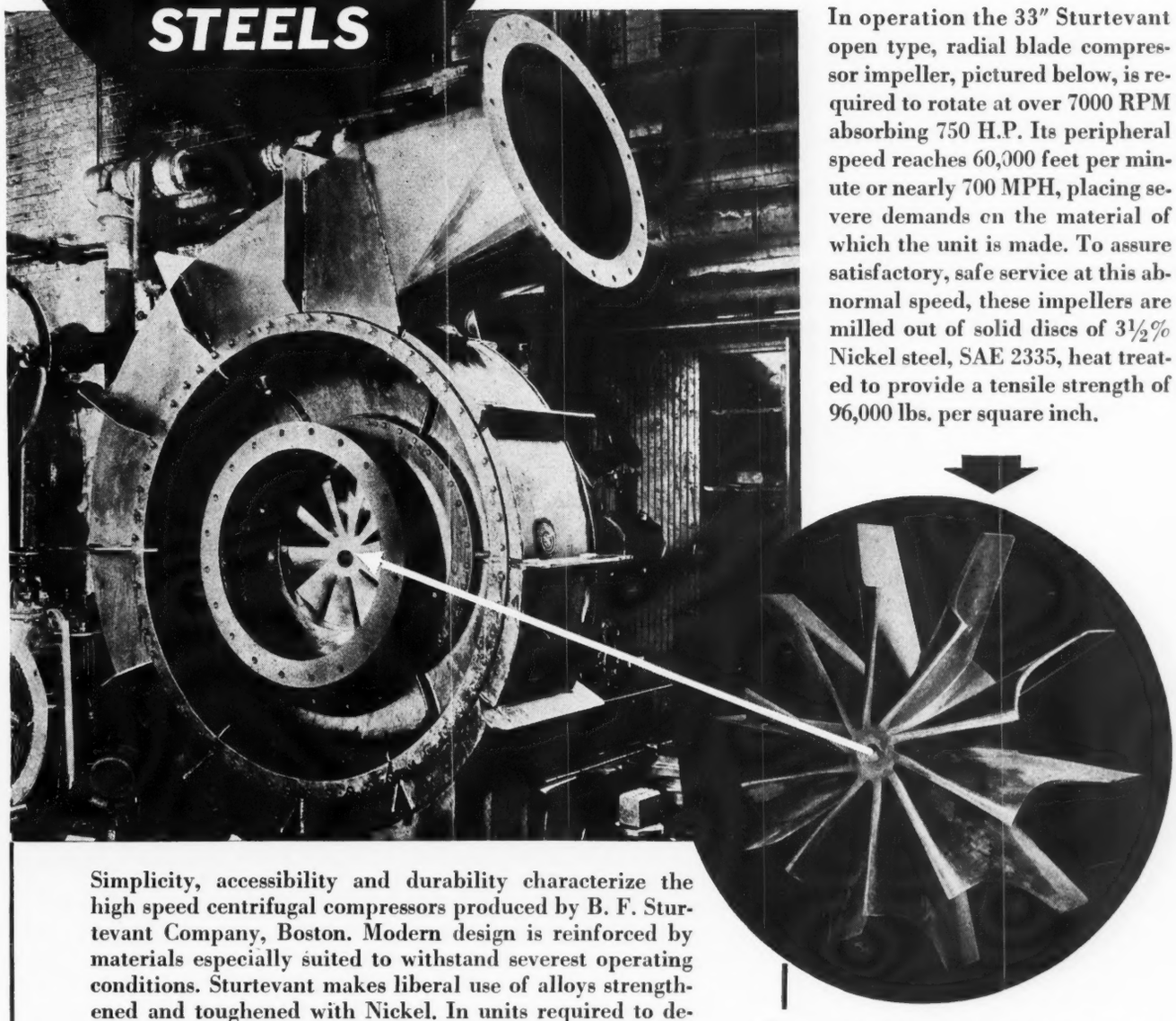
**14** SPEED CONTROLS—Reeves Pulley Co, Columbus, Ind. 8-page folder

ALLOY

# NICKEL

STEELS

## 7000 TIMES EVERY MINUTE Sturtevant fans demonstrate their TOUGHNESS

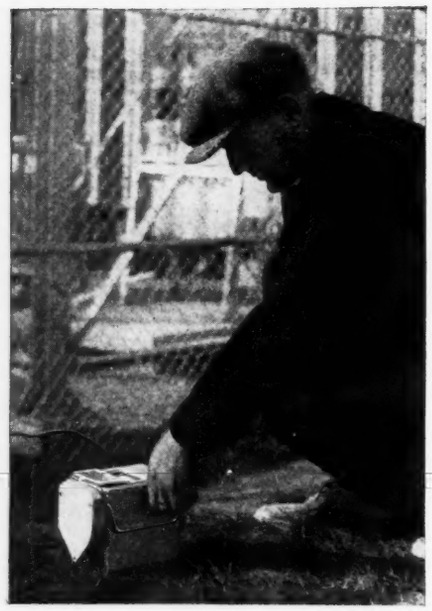


In operation the 33″ Sturtevant open type, radial blade compressor impeller, pictured below, is required to rotate at over 7000 RPM absorbing 750 H.P. Its peripheral speed reaches 60,000 feet per minute or nearly 700 MPH, placing severe demands on the material of which the unit is made. To assure satisfactory, safe service at this abnormal speed, these impellers are milled out of solid discs of 3½% Nickel steel, SAE 2335, heat treated to provide a tensile strength of 96,000 lbs. per square inch.

Simplicity, accessibility and durability characterize the high speed centrifugal compressors produced by B. F. Sturtevant Company, Boston. Modern design is reinforced by materials especially suited to withstand severest operating conditions. Sturtevant makes liberal use of alloys strengthened and toughened with Nickel. In units required to deliver large volumes at high pressure impellers are 3½% Nickel steel, SAE 2335. In other units circulating air at temperatures up to 1200°F., and also for corrosive gasses, Sturtevant specifies Monel as fan material. For stressed units in new or replacement equipment, specify Nickel-containing alloys. They stay right on the hardest jobs in your plant.

Economical production of power requires plant equipment to withstand severe operating conditions. Time-proved Nickel alloyed materials have been developed to meet those needs. Practical information about such materials is available promptly upon your request. Please address:

**THE INTERNATIONAL NICKEL COMPANY, INC.**
67 WALL STREET
NEW YORK, N. Y.



# "MEGGER"

TRADE MARK REGISTERED U.S. PAT. OFF.

## GROUND TESTER

### helps eliminate $2500 annual loss due to lightning

**A municipal power system covering about 150 square miles in an eastern state, had been experiencing transformer failures due to lightning to the tune of 20 or more each season. These cost about $125 each—a yearly loss of $2500.**

**In 1936 they purchased a "Megger" Ground Tester, and started to improve their grounds by installing multiple grounds, and by salting. Result: In 1937 they had three outages, in 1938—two, and in 1939 only one that was traceable to lightning and high ground resistance.**

***Because the "Megger" Ground Tester is simple, direct-reading, reliable and rugged, it at once minimizes all difficulties of testing procedure, and also provides the basis of any program of grounding improvement.***

***Write for our "Megger" Ground Tester Catalog No. 1645-P***

**JAMES G. BIDDLE CO.**
ELECTRICAL AND SCIENTIFIC INSTRUMENTS
1211-13 ARCH ST. PHILADELPHIA, PA.

N. Y. 6-page folder illustrates, points out advantages, and describes R C Allen 10-key electric calculator, which adds, subtracts, multiplies and divides. Partial list of calculator users included, as well as short item on hand-operated model.

**54** PACKINGS—Greene, Tweed & Co, 101 Park Ave, New York, N. Y. 12-page bulletin has descriptive information on mechanical pump packings and sheet packings. Chart lists each type of packing and tells under what conditions, in what substances each particular packing is suited. Tables of lengths also included.

**55** FLOORING—Flexrock Co, 23rd & Manning Sts, Philadelphia, Pa. 4-page leaflet covers new type of flooring material, citing typical applications, with photos illustrating installations.

**56** SPRAY EQUIPMENT—Spray Engrg Co, 114 Central St, Somerville, Mass. 12-page catalog covers all equipment made by company. Includes listing of direct-pressure spray nozzles, spray guns, atomizing spray heads, Spraco air washers, spray cooling systems, humidifying systems, moistening equipment, and other spray and spray finishing machines.

**57** WIRE ROPE HANDBOOK—American Cable Div, American Chain & Cable Co, Wilkes-Barre, Pa. 40-page book concerns elevator wire rope, giving mechanical data, safety factors given by American Engineering Standards Committee, and record blanks for use by engineer in recording all important data.

**58** COOLING SURFACE—John J Nesbitt, Inc, Homesburg, Philadelphia, Pa. 4-page folder describes advantages of new type water surface, giving construction details of same.

**59** OIL HEATERS—Standard Heater & Equipment Co, 245 Cornelison Ave, Jersey City, N. J. Bulletin 101 describes fuel oil heaters, giving engineering details, construction, and design data.

**60** LOCK NUT—An-Cor-Lox Div, Laminated Shim Co, Inc, Glenbrook Station, Conn. 4-page leaflet describes positive, all-purpose lock nut that can be used repeatedly. Employs new principle of locking; made in all sizes, all metals.

**61** MECHANICAL PACKINGS—A W Chesterton Co, 64 India St, Melrose, Mass. 20-page Catalog No. 20 covers only those packings essential to efficient plant maintenance, eliminating hodgepodge of overlapping and duplicating styles. Recommendation chart shows style best suited to various packing problems. Also includes data on tube scrapers.

**62** DRAFTING MATERIALS—Ozalid Corp, Johnson City, N. Y. 4-page illustrated bulletin No. 187 describes Model F printer developer for reproducing drawings, etc. Gives dark lines on white paper and is a dry process. Accommodates materials up to 42-in. wide and has maximum printing speed of 36 in. per minute. Photos show construction, tables give production details and capacities.

**63** HYDRAULIC EQUIPMENT—Blackhawk Mfg Co, Milwaukee, Wis. Catalog No. 40H covers "Porto-Power" pipe and conduit benders, remote-control jacks; also hydraulic hand jacks, gage-equipped hydraulic jacks, inverted hydraulic hand jacks, and wheeled service jacks. Drawings and photos show construction and use, charts and tables list capacities and specifications.

**64** WATER-TREATMENT PROBLEMS—Hall Laboratories, Inc, Pittsburgh, Pa. Pamphlet entitled "Seventeen Case Histories from the Files of Hall Laboratories," presents material extracted directly from client files, in a brief, straightforward and personal manner, without embellishment. Provides a good insight into various water problems existing in representative plants throughout the country and relates how these problems were solved through the Hall system of boiler-water conditioning.

**65** TEMPERATURE REGULATORS—Foster Engineering Co, 109 Monroe St, Newark, N. J. 16-page booklet, Catalog 70—Bulletin 11, covers Foster Type T temperature regulators for steam, air, liquids and gases. Handsomely illustrated in 2 colors, with many photos, cutaway and line drawings. Charts and tables give complete data on performance, application, etc.

# LET FERRISUL HELP YOU RE-USE YOUR CONDENSATE

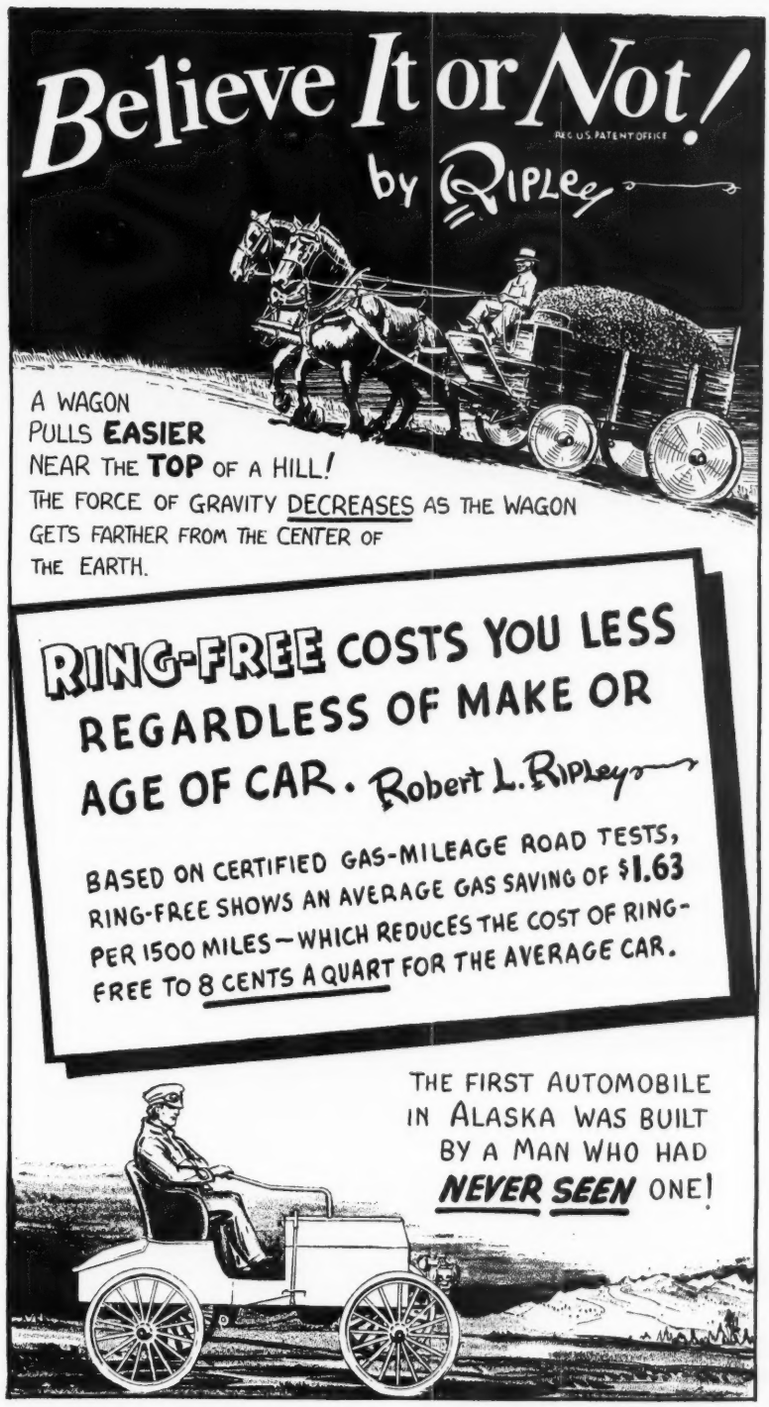
The heat in your condensate represents money to you because of the cost of the water and fuel used. Don't chance losing this investment simply because of danger from emulsified oil—let Ferrisul remove this oil easily, safely and completely.

By treating with Ferrisul (anhydrous ferric sulfate), you will be able to save time and money. A safe and dependable coagulant for pretreatment of feed water, Ferrisul is effective at all water temperatures, removing silica in a quick-settling floc and leaving no scale-forming residues. The Ferrisul floc is stable over the entire pH range above 3.5.

Easy to handle and easy to store, Ferrisul means more economical operation in your plant. Write today for further information. MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston, Massachusetts.

**FERRISUL**
For
Boiler Water Treatment

**MONSANTO CHEMICALS**
SERVING INDUSTRY . . . WHICH SERVES MANKIND


Believe It or Not!
REG. U.S. PATENT OFFICE
by Ripley
A WAGON PULLS EASIER NEAR THE TOP OF A HILL! THE FORCE OF GRAVITY DECREASES AS THE WAGON GETS FARTHER FROM THE CENTER OF THE EARTH.
RING-FREE COSTS YOU LESS REGARDLESS OF MAKE OR AGE OF CAR. Robert L. Ripley
BASED ON CERTIFIED GAS-MILEAGE ROAD TESTS, RING-FREE SHOWS AN AVERAGE GAS SAVING OF $1.63 PER 1500 MILES—WHICH REDUCES THE COST OF RING-FREE TO 8 CENTS A QUART FOR THE AVERAGE CAR.
THE FIRST AUTOMOBILE IN ALASKA WAS BUILT BY A MAN WHO HAD NEVER SEEN ONE!

**Look again at the simple arithmetic above. It proves that, for diesels too, Ring-Free becomes the cheapest motor oil you can buy. Here's why: Ring-Free saves fuel because it reduces motor friction better and faster. By reducing friction it releases more power from the motor. Even more important, this reduced friction means less wear, less motor repair. And still further savings! Proof? Call the Macmillan Man or write us direct.**

*Believe it or not!** **Babbidge & Holt, Inc., Portland, Oregon,** operate the 270 h.p. diesel Motorship "Northbeach." Before using Ring-Free they were having considerable trouble with stuck rings and excessive wear. This meant overhauling bearings, rebabbitting and labor. Here's what they say since using Ring-Free: "Repouring of bearings was positively eliminated. Machine shop costs were reduced 90%. Where oil changes had been made every 200 hours, we could safely operate 600 hours without change. We take pleasure in highly recommending this oil."

*Believe it or not!** **Walter Horn of Shoemakersville, Penn.,** says of his Caterpillar Stationary Diesel: "Here are a few more "Believe-it-or-nots" for you . . . this diesel operated 1500 hours on Ring-Free without an oil change . . . oil consumption is one quart in seven days (operating 11 to 24 hours per day) . . . when this engine was pulled down and examined after 1500 hours the original finish and tool marks were still discernible on pistons, cylinders and crankshaft."

*Believe it or not!** **Uvalde Construction Company, Dallas,** using Ring-Free in many types of equipment, report Ring-Free has set a new high in performance . . . a new low in maintenance delays.

**DISTRIBUTORS: A few territories in the United States are still available to live distributors who can qualify. Write for particulars.**

* Reg. U. S. Patent Office

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**MACMILLAN PETROLEUM CORPORATION**

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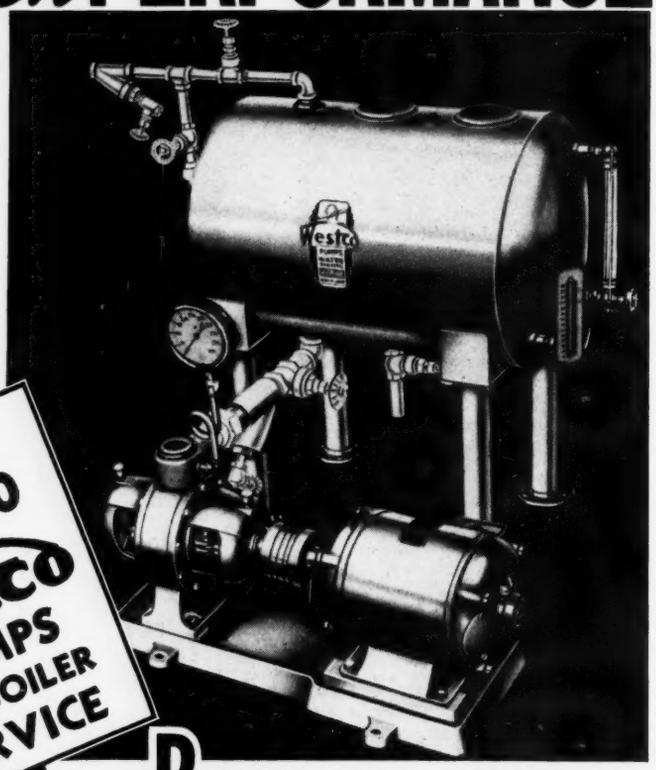
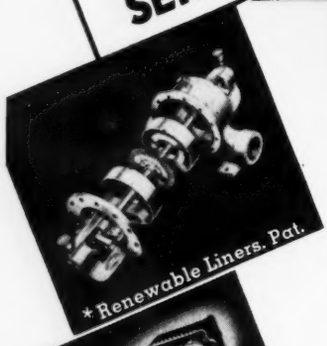
# Proven PERFORMANCE




OVER 25,000 Westco PUMPS ON BOILER SERVICE



## BOILER FEED SYSTEMS

Only Westco Systems have the original Westco Turbine-Type Pumps . . . with patented, renewable liners! This exclusive feature minimizes shut-down losses . . . permits stand-by protection at 1/3 the usual cost. You cut maintenance expense . . . and fuel bills! Investigate today!

### FEATURES

1. Westco automatically returns all condensate to the boiler.
2. Make-up water automatically added as needed . . . without appreciable pressure drop in boiler.
3. Constant water level in boiler maintained at all times . . . insures uniform steam space.
4. Always on duty . . . keeps return lines constantly open!
5. Back pressure on return lines is completely removed. Condensate drains continuously into receiver.
6. Westco Systems use no steam, are inexpensive to operate. Easily installed in minimum space.

MICRO-WESTCO, INC., 44009 State St., Bettendorf, Iowa
Gentlemen: We want to cut costs. Tell us about Westco.

Name ..... Address .....

City ..... State .....

MICRO-WESTCO, INC.


*(Continued from page 164)*

of the board of Combustion Engineering, Inc, which at that time became affiliated with the Superheater Co.

## PERSONALS

TOM H JONES has joined Bradshaw & Co, sales engineers, in the Pittsburgh, Pa., district. Mr Jones was formerly with Johnston & Jennings Co, and with Ohio Leather Co.

A ERNEST THOMAS, supervising engineer of the Dime Savings Bank of Brooklyn, has been elected president of the Greater N. Y. Assn No. 1, National Association of Power Engineers. Other officers include William Wrightson, vice-president; Fritz Schultz, treasurer; Harry Waite, corresponding secretary; James Negley, financial secretary. The elections were held at the regular monthly meeting.

CHARLES C PLUMMER, formerly sales manager of the Bigelow-Liptak Corp, has joined Hoffman Combustion Engineering Co, as vice-president in charge of the Western Division. He will have his headquarters in Chicago.

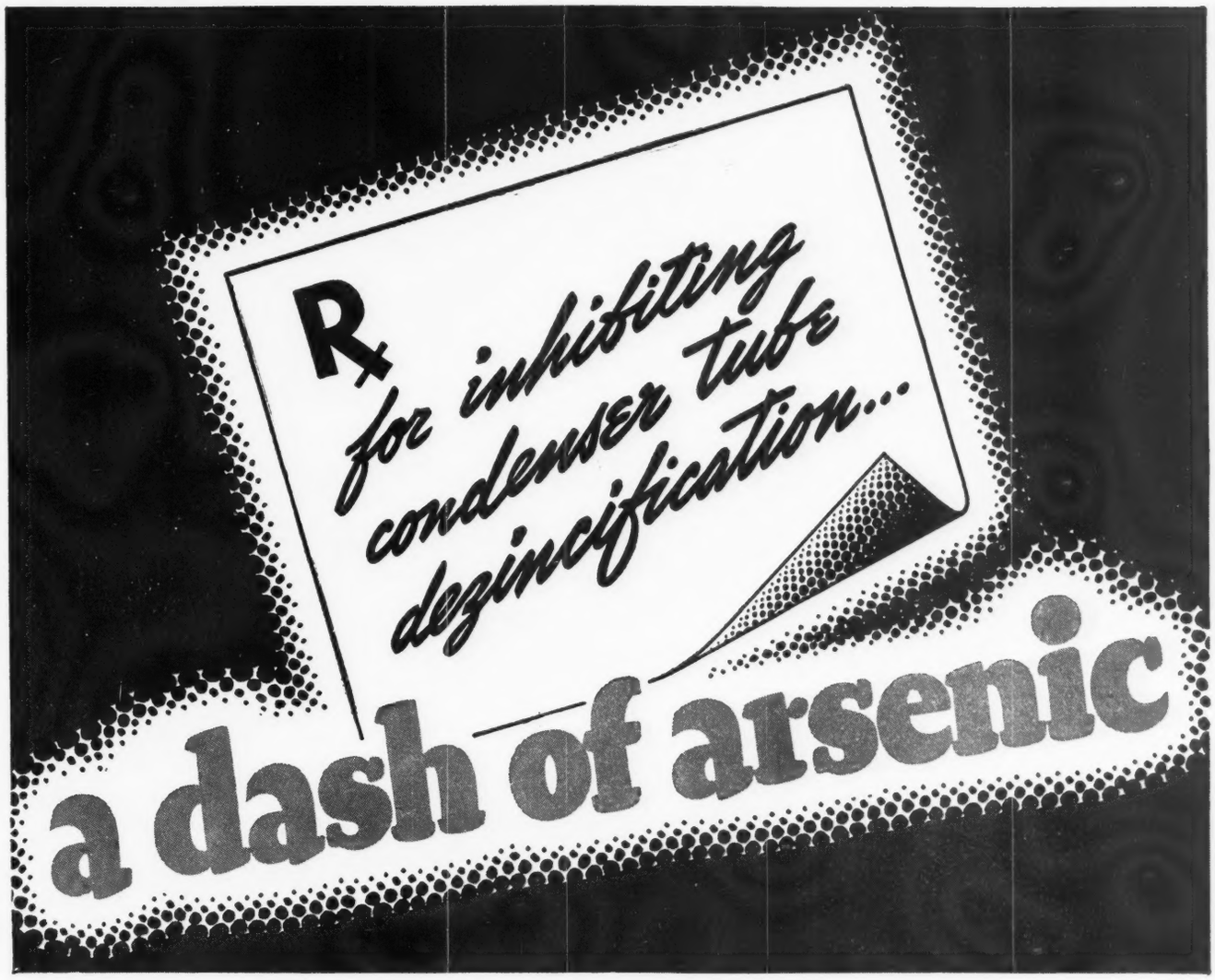
CLINTON E STRYKER has been appointed vice-president and assistant to the president of the Nordberg Mfg Co, Milwaukee, Wis. Mr Stryker was a partner in McKinsey, Kearney & Co, management engineers, of Chicago, having been with that firm for five years. Prior to that he was with Fansteel Metallurgical Corp.

COLONEL L B LENT, well known engineer, inventor and trade association executive, has been appointed executive secretary of the American Engineering Council. He succeeds Frederick M Feiker, who resigned recently to become dean of engineering at George Washington University. Colonel Lent is a graduate of Stevens Institute of Technology. His experience record includes five years as associate editor of POWER, several years with Ford Motor Co, service with the Army during the World War, and more recently as a consultant in the aviation field.

M A CARPENTER has been elected vice-president and director of The Falk Corp, Milwaukee, Wis. Mr Carpenter has been with Falk for the past 16 years.

C D BLACKWELDER, well-known chemical and mechanical engineer, and partner in firm of J E Sirrine & Co, was recently initiated into North Carolina State College chapter of Tau Beta Pi, national honorary engineering fraternity. T K Mial, vice-president and general sales manager of Johns-Manville Co, New York, and C L Garner, chief of the Geodesy Div, U S Coast & Geodetic Survey, Washington, D. C., were also inducted into the organization at the same time.

DAVID DASSO, formerly New York representative of Sulzer Bros, Ltd, Switzer-




The failures of alloys of copper and zinc through dezincification has long been a problem to both producer and consumer of alloys subject to corrosive media.

The failure of condenser tubes by reason of dezincification has been the subject of widespread and intensive study over a period of many years. A digest of the published records of this study, both as conducted here and abroad, clearly points to a general conclusion that arsenic in percentages as low as 0.02% in Admiralty Condenser Tubes inhibits dezincification.

A further conclusion is that arsenic also does *not* have undesirable effects on Admiralty metal. There is no tendency towards season-cracking and stressless intergranular corrosion does not occur.

The use of arsenic as an inhibitor of dezincification antedates the use of other practical inhibitors. There has thus been a longer time for field studies and practical experiments to confirm the advantages of arsenic.

In the past three years 46 Admiralty Heat Exchanger Tubes from many sources were examined. The results are:

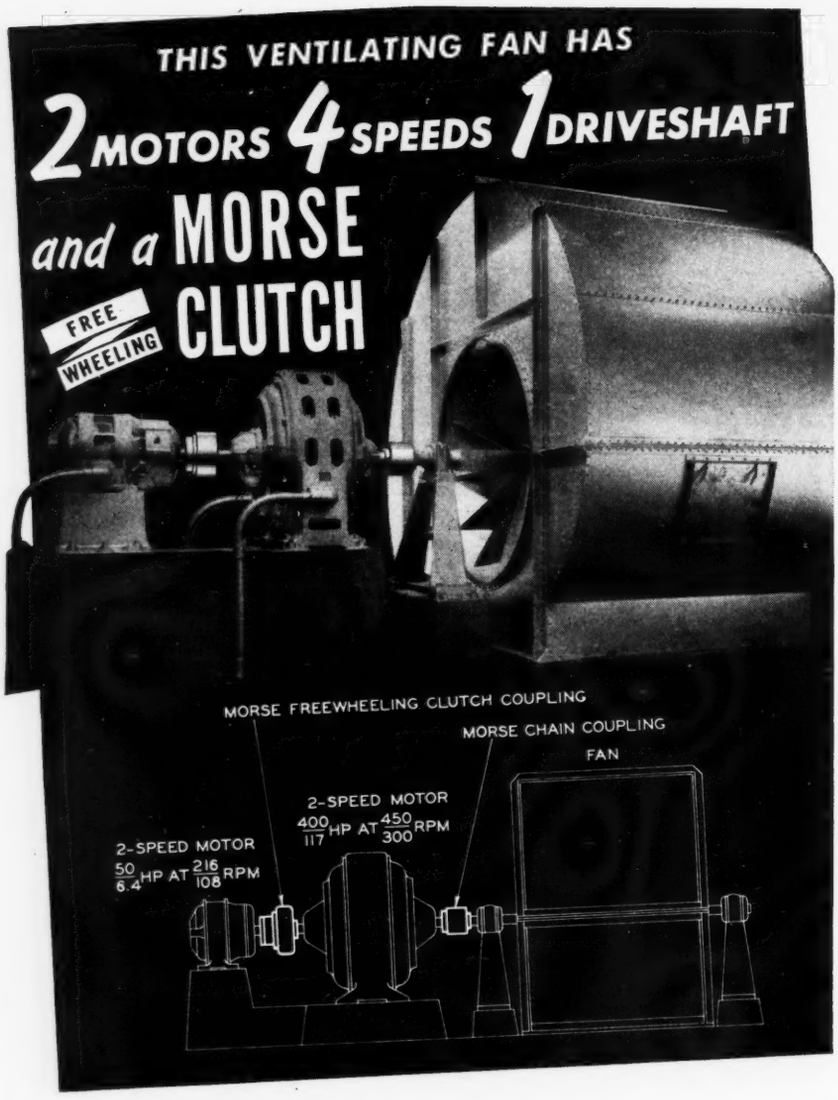
| NO. OF TUBES | % FAILURE THROUGH DEZINCIFICATION |
|---|---|
| 36 tubes without commercial amounts of arsenic | 36 |
| 10 tubes with .02% to .06% arsenic | *none* |

Consider the advantage of selecting Revere Arsenical Admiralty Tubes for maximum over-all economy. Replacement costs, shut-down costs, and damage costs due to tube failure may be cut considerably by specifying Revere Admiralty Condenser Tubes in your installations.

Since each condenser tube installation presents an individual problem, we invite you to use the Revere Technical Advisory Service in helping you select the best tube for maximum service and economy. This service is free for the asking.

**REVERE COPPER AND BRASS INCORPORATED**

*Executive Offices:* 230 Park Avenue, New York, N. Y.




THE Morse Free Wheeling Clutch, used between the two motors, gives this installation its flexibility. This clutch allows speed changes, starts or stops at any time—without speed relays, centrifugal switches, or an expert operator's attention.

When the 2-speed, high-speed motor is in operation, the Morse Clutch free wheels. When speed is reduced, the pressing of a switch button cuts in the slow-speed motor and cuts out the high-speed motor, at which time the clutch free wheels until fan and high-speed motor come down to the slower speed. The clutch then automatically engages.

Fan drives protected with Morse Free Wheeling Clutches are money and equipment savers. No chance for ruined motor windings, damaged fans or drives. Extreme flexibility in speed selection with resulting power economies.

**Get NEW Clutch Engineering Bulletin**

Complete information on Morse Free Wheeling Clutches, with detailed case studies of ten typical applications. Dimensions, prices, engineering data, installation and use instructions. Write for Bulletin K-12 today!

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO CLUTCHES

MORSE positive DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.


land, and vice-president of the American Locomotive Co, has been appointed Secretary of the Treasury (Ministro de Hacienda), Republic of Peru. Mr Dasso returned to that country the latter part of 1939.

JAMES D FLEMING has been appointed vice-president and sales manager of the Grinnell Co, Inc, Providence, R. I. Previous to this appointment, Mr Fleming was vice-president and manager of the Grinnell Co of the Pacific, a subsidiary. He has been associated with that company since 1919. He will continue to manage the Pacific company, but will be located at the company's home office in Providence.

BERRIEN MOORE has been appointed manager of the Florida district of Allis-Chalmers Mfg Co, with headquarters at Tampa. Mr Moore has been with Allis-Chalmers since 1908, when he joined the company as a hydraulic sales and textile engineer. While serving in that capacity he spent considerable time in North and South Carolina, working with the Southern Power Co. In 1917 he was appointed manager of the Atlanta District offices and continued in that position up till his present appointment.

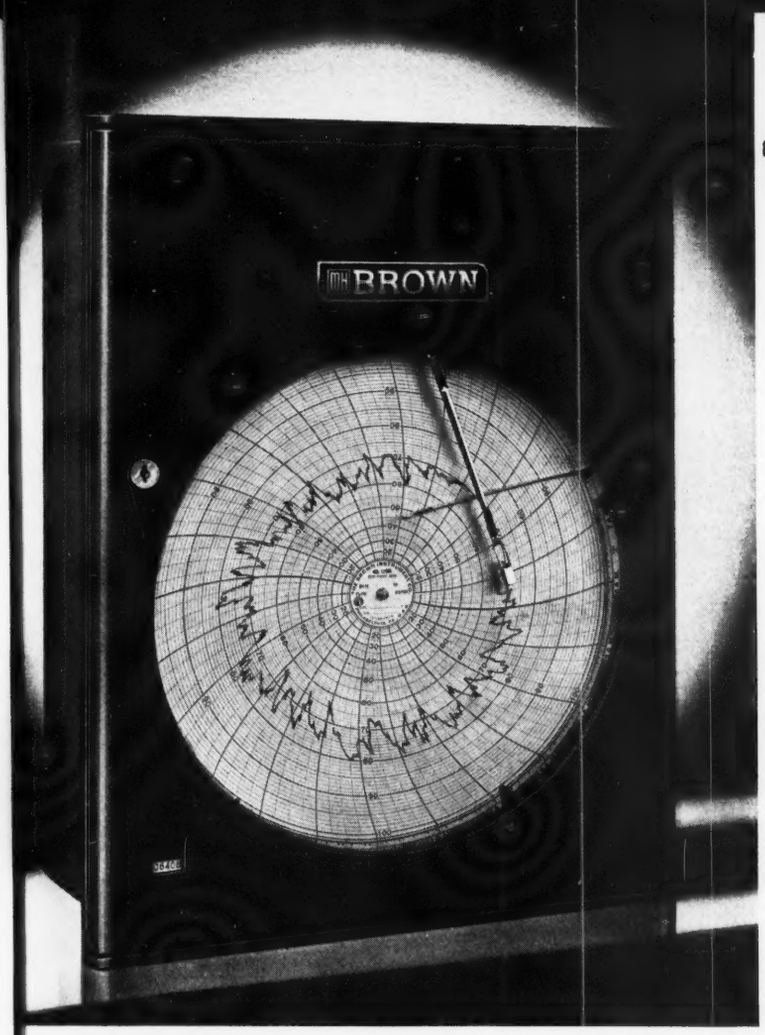
HENRY W BRYANS was recently elected a member of the Board of Directors of the Philadelphia Electric Co. Mr Bryans has been executive vice-president of the company since October, 1938, prior to which he was vice-president in charge of operations. He was elected to fill a vacancy caused by the resignation of W H Taylor from the board.

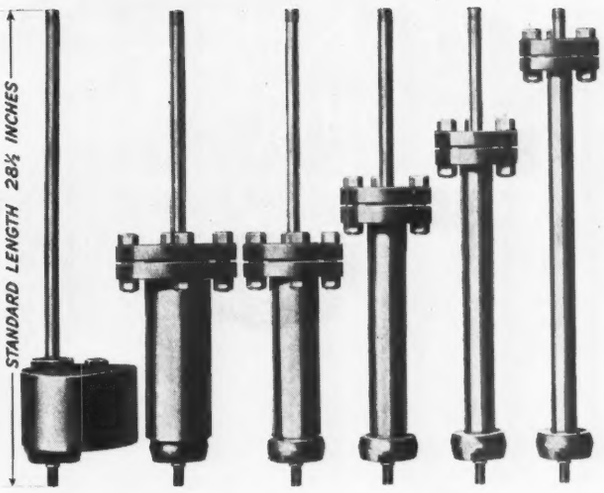
W A EVANS, who has been associated with the Carrier Corp and its subsidiaries in New York, Atlanta, and Detroit, has settled in Cleveland as district manager of Aerofin Corp, which is associated with Carrier. His territory includes Ohio, Western Pennsylvania, Kentucky and Tennessee.

ROLAND WHITEHURST, formerly Washington branch manager, Electric Storage Battery Co, has been appointed assistant general sales manager with headquarters in company's home office in Philadelphia. He has been in the employ of the company since 1908 and has been manager of the Washington branch for 20 years. He was formerly attached to the New York branch.

JOHN J CROWE, formerly manager of Apparatus Research and Development Dept, Air Reduction Co, has been appointed assistant to Herman Van Fleet, vice-president and operating manager. Mr Crowe will direct the activities of the department which he headed, and will coordinate these activities with similar activities for Wilson Welder & Metals Co, Inc. In addition, he will handle patent matters for Mr Van Fleet.

ARCHIE CHANDLER has been elected vice-president in charge of sales of American Pulley Co. Philadelphia. Mr Chandler first became associated with American Pulley in 1915 as district sales manager in charge of the Pacific Coast territory. In 1928 he was named general sales manager of the company.




# Range-Changing Easy, Quick, Inexpensive

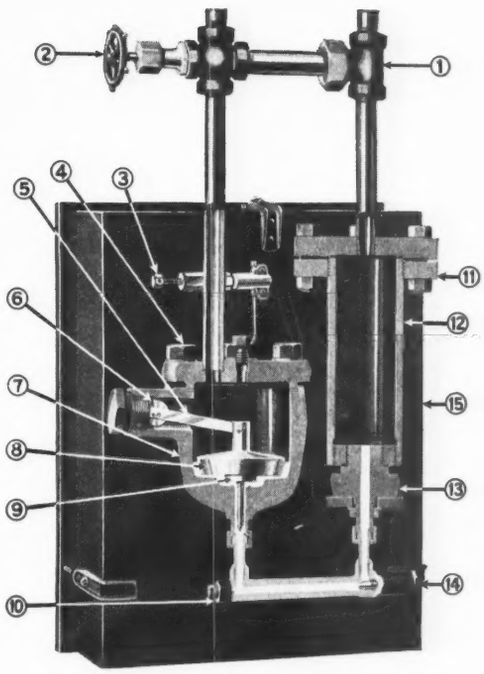
It is often necessary for plants to change the range of flow meters to meet different operating conditions. Users of Brown Flow Meters find such changes can be made quickly, easily and inexpensively by simply substituting a new range tube of the proper size.

If the original flow is found in error, as it is in many cases, or the average rate of flow changes, as it frequently does, the orifice need not be disturbed, nor another meter body installed to obtain the range required.

Seven interchangeable range tubes make it possible to get a four to one change in meter capacity in steps of roughly 25%.

In addition, other range tubes of 25-inch, 50-inch, 100-inch and 200-inch differential capacity are available.

Send for complete information. Write for Catalog No. 2203 describing many other advantages of Brown Flow Meters. THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co.*, 4490 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter Street—Amsterdam-C, Holland: Wijdesteeg 4—England: Wadsworth Road, Perivale, Middlesex—Stockholm, 16, Sweden: Nybrokajen 7.

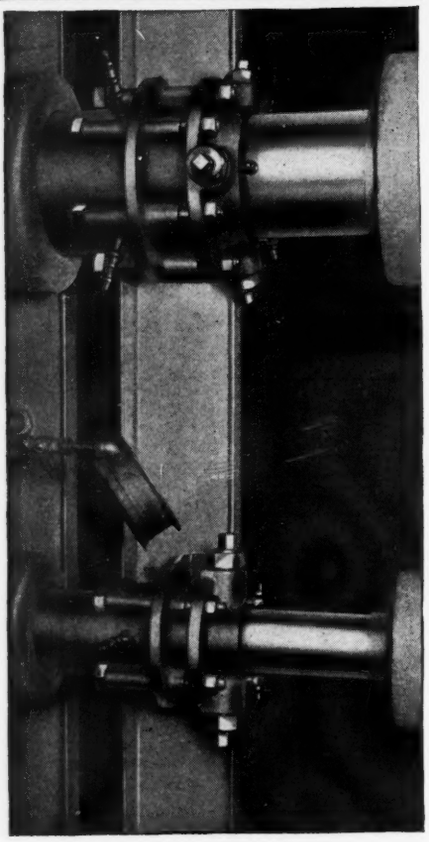



1. Valves and Piping. 2. Equalizing Valve. 3. Lubricator. 4. High-Tensile Strength Bolts. 5. Float Lever. 6. Pressure-Tight Bearing. 7. Meter Body. 8. Float. 9. Mercury Safety Seal. 10. "U" Tube. 11. Flanges. 12. Range Tube. 13. Range Tube Support. 14. Pulsation Check. 15. Rectangular Case.

# BROWN Flow Meters

*Accurate Measurement with Simplicity*

YARWAY
GUN-PAKT
EXPANSION
JOINTS



## Big Automobile Company Uses 67 Yarway Joints

First purchased 3 years ago. Reordered 7 times to present total of 67 Yarway Gun-Pakt Joints, ranging in size from 3 in. to 14 in.

Why don't you select the Expansion Joint that is packed under full steam pressure. A twist of a wrench forces a special semi-plastic packing into the stuffing box by means of integral pressure guns. No need to remove old packing. New packing rejuvenates the old. No need to shut off steam. Write for Catalog EJ-1907.

YARNALL-WARING CO.
100 Mermaid Ave., Phila., Pa.

LOUIS M BENKERT, associated with the company since its founding in 1935, is now general manager of Progressive Welder Co, Detroit. Since joining the company, Mr Benkert has successively headed the service, engineering, estimating and sales departments.

DAVID C PRINCE, since 1931 chief engineer of Switchgear Dept, General Electric Co, has been named manager of the Commercial Engrg Dept, succeeding the late vice-president, E W Allen. Mr Prince has also been appointed a member of the company's advisory committee, and the apparatus sales committee. He will make his headquarters in Schenectady.

WILLIAM B DOBSON has been appointed works manager of the Oil City Tank and Boiler Co, Oil City, Pa. For many years Mr Dobson was superintendent of the Heating Boiler Division of Struthers-Wells Titusville Corp. Prior to this time he was with the Petroleum Iron Works Co, Sharon, Pa., in a similar capacity.

## "Coal Industry Prepared for All Emergencies"

The bituminous coal industry is equipped and ready to meet increased fuel demands of industry incident to the immense program of preparedness and national defense, according to a speech presented by J D Battle, executive secretary of the National Coal Association, at a meeting of the traffic staff and other officials of the Chesapeake & Ohio Railway held in July.

"Let me say that our industry, in so far as the production of coal is concerned, is equipped and ready to meet the increased fuel demands of industry in the national defense program, and the railroads tell us that they are ready and equipped to meet whatever the increased load," said Mr Battle. "I am confident, therefore, regardless of anything that may happen in other directions, that the experiences of the World War with respect to fuel shortage and transportation tie-ups will not be repeated. The coal industry has sufficient plant capacity to maintain without overload a weekly coal output at a ten- or eleven-million-ton level, and a twelve-million-ton or more level, if the ne-

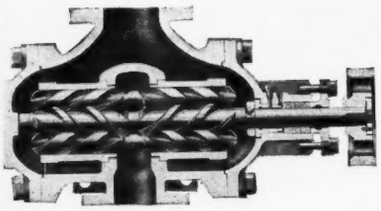
## MEETINGS

**American Society of Mechanical Engineers** —*Fall Meeting, September 3–6, Hotel Davenport, Spokane, Wash. C E Davies, secretary, 29 W 39 St., New York, N. Y.*

**Association of Iron & Steel Engineers**— *National Convention, September 24–27, Chicago, Ill. Brent Wiley, managing director, Empire Bldg., Pittsburgh, Pa.*

**National Electric Mfrs. Assn.** — *Annual Meeting, October 27–November 1, Waldorf-Astoria Hotel, New York, N. Y. W J Donald, director, 155 East 44th St, New York, N. Y.*

**New York Power Show** — *Grand Central Palace, New York, N. Y., December 2–7, 1940. Management, International Exposition Co., New York, N. Y.*



Gambling may be fun

BUT- should your turbine, engine or oil burner fail through failure of the oil pump, the cost of that failure might be many times the cost of the oil pump; so why gamble on the oil pump?

The DE LAVAL-IMO OIL PUMP is a guarantee against oil handling troubles.

It has no valves, no gears and only one stuffing box and does not depend upon close clearances.

It pumps all grades of oil, including light Diesel oil, lubricating oil and heavy Bunker C, against all pressures.

Ask for Catalog 1-63.

IMO means I MOVE OIL

DE LAVAL
STEAM TURBINE CO.
Trenton, New Jersey

Save Air—Save Dollars
WITH
ROCKWELL
BLAST GATES

Threaded Slide Type

Flanged Slide Type

For Low Pressure Air

•

Slide Type
Butterfly Type
Wafer Butterfly Type
Kwikleen Type

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Write for catalog No. 3760

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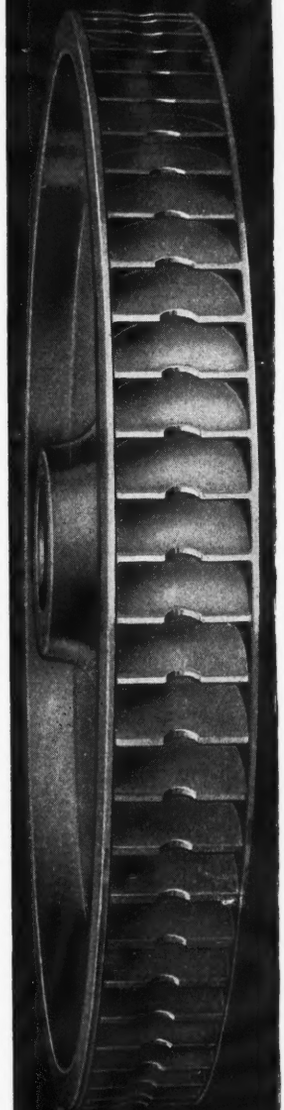
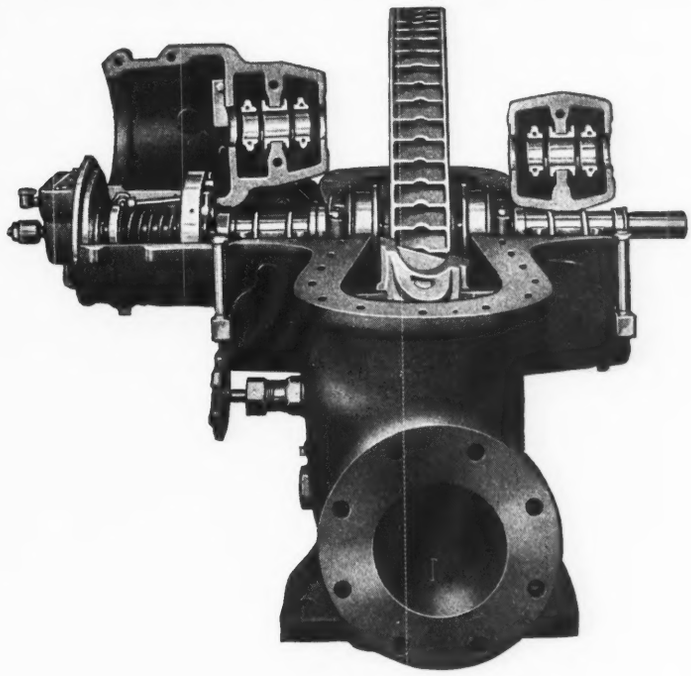
W. S. ROCKWELL COMPANY
50 CHURCH ST., NEW YORK

# TERRY





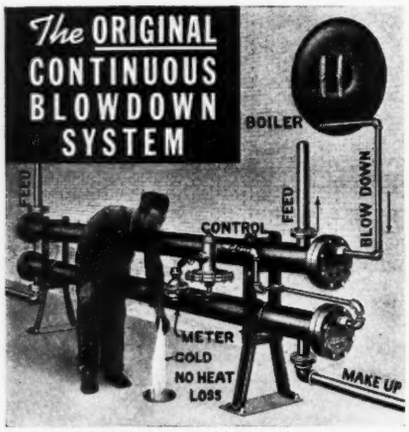
## ROTOR AND BUCKETS ALL IN ONE PIECE

In the Terry Turbine the wheel is made from a single forging of special composition steel. The buckets are milled directly in the wheel, there are no parts to become loose or work out, such construction makes for long life and low maintenance.

This and many other features of Terry Wheel Turbine design are described in our Bulletin S-116. A request on your business letterhead will bring a copy.

T-1138

**THE TERRY STEAM TURBINE COMPANY**
**TERRY SQUARE, HARTFORD, CONN.**




**HENSZEY**
**CONTINUOUS BLOWDOWN**
*makes*
**$50,000 SAVING**
*in 10 years on a*
**$1000 INVESTMENT**

The boilers of a large cotton oil plant* in Mississippi had been priming, foaming and were scaled due to the high concentration of solids in the boiler water. Adequate blowdown wasted so much heat that the boilers could not handle the load.

In 1930 they installed a Henszey Continuous Blowdown System. After that, due to the heat recovery feature, the boilers could easily handle the load. Their bill for natural gas, used as fuel for the boilers, dropped over $400 per month. They have, on this item alone, saved over $5,000 a year or a total of over $50,000 to date.

In addition, boiler and engine repairs have been reduced 50%—packings last longer—cylinder oil consumption has been reduced—boiler capacity increased 10% and boiler efficiency raised 5%.

Send for information on such an investment for your boiler plant. Remember—only Henszey can give you complete, automatic, continuous blowdown without heat loss.

**Name and complete information on request.*

**HENSZEY COMPANY**
**Dept. D9** **Watertown, Wis.**

**HENSZEY**
**BOILER WATER CONCENTRATION CONTROL SYSTEMS**


cessity arises and the man power is available. So, if the railroads supply the cars and are permitted to operate their roads, there need be at no time any specter of a coal famine or industrial delay attributable to fuel delay."

## Montaup Electric Co Adds 20,000-kw Unit

Montaup Electric Co, Somerset, Mass., has placed an order for a new 20,000-kw turbine-generator with the General Electric Co, to be installed by Stone & Webster Engineering Corp, Boston. Unit will operate at 1800 lb, 950 F, and will be part of a program involving the expenditure of $3,000,000 to provide additional power facilities for this plant.

## Engineering Foundation Forms Research Committee

Engineering Foundation, research organization of the national engineering societies, has formed a Structural Steel Welding Research Committee to study problems of design and fabrication in the building field. The program includes the establishment of research fellowships in American Universities. First fellowship goes to Lehigh University for a two-year period and carries with it an annual award of $1,100. Other fellowships will be established as soon as the committee maps a complete program of research projects. The investigations at Lehigh will be directed toward developing a satisfactory design procedure for beam-to-girder and beam-to-column connections for all kinds of welded building construction.

## Buda Co to Produce Aircraft Diesel Engine

The Buda Co, Harvey, Ill., has undertaken production of an aircraft diesel. Developed cooperatively with Guiberson Engine Co, Dallas, Tex., the engine is a 9-cylinder, radial, air-cooled unit rated 310 hp at 2200 rpm.

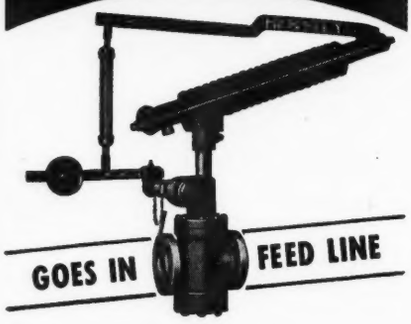
According to the makers, the engine approaches a gasoline engine in power output. High-altitude tests show that engine maintains about 75% of full load pressure, as compared to 50% for a gasoline engine.

# Current Comment

## One Way to Test Cylinder Oils

MANY YEARS AGO, Prof Thurston proposed a method of testing lubricants by embedding a thermometer in the bearing and noting the temperature. This method I thought crude, even for lubricants in bearings, and especially misleading for steam-cylinder oils, particularly with high pressure and superheating. Under certain con-


**HENSZEY**
**BOILER FEED REGULATORS**




The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions!

**These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary — nothing to get out of order — nothing to reset.**

***Send for latest Bulletin containing full details.***

**HENSZEY COMPANY**
**Dept. D9—Watertown, Wis.**

★ The Heart of the Gauge gives LIFE to its performance!

And—in LONERGAN Gauges—all materials are chosen carefully for their purpose, are of the best grade and are fabricated with utmost care to precise standards. They are so guaranteed!

Model "GH" Hydraulic Gauge—Tubes of bar tool steel, Stainless Steel, or Inconel, are turned, drilled and formed, then threaded and sweated into connections.

**Lonergan**
A COMPLETE LINE OF
★ ★ ★ *Gauges*
**VALVES • SPECIALTIES**

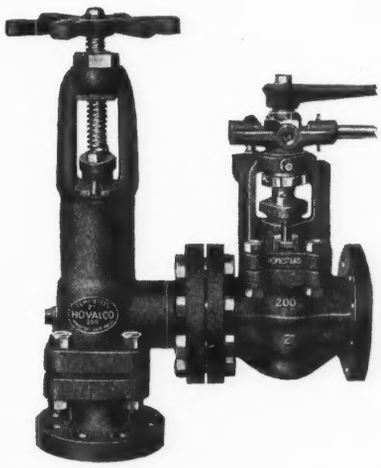
**J. E. LONERGAN CO., Race & Second Sts., Phila.**
300 SPECIALTIES FOR POWER PLANTS—SINCE 1872

# *Nominated!* FOR THE 1940 POWER AWARD

A Blow-Off Combination
Renowned for Low Up-Keep

A Blow-Off Combination
That outlasts its own Boiler

HOVALCO-HOMESTEAD



BLOW-OFF VALVES

A Blow-Off Combination
Unbeatable for Long Service

A Blow-Off Combination
Which, Once Used, is Always Used

"Why not have *Power Awards* for outstanding power equipment performance?" O.K.—we are for it; and here's a blow-off valve combination that would get thousands of votes for its long, low-cost-per-year performance on all types of boilers for the past 25 years.

For long life, absolute efficiency and maximum economy, put this blow-off combination on your boilers and stop worrying about leaky seats or wasted heat units. Reference Book No. 38 will help you to choose the right combination for your boiler pressure. Write for your free copy.

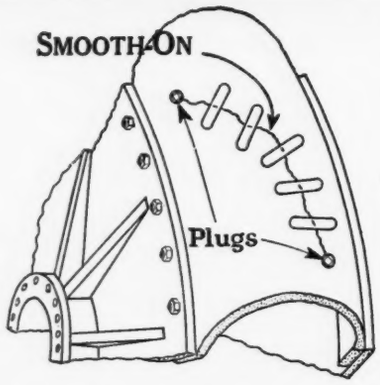
HOMESTEAD VALVE MANUFACTURING CO., P. O. Box 210, Coraopolis, Pa.

HOMESTEAD VALVES

QUARTER-TURN VALVES:
STRAIGHT-WAY
THREE-WAY
FOUR-WAY
LUBRICATED TYPE
LIFT-TYPE PLUG

PROTECTED-SEAT VALVES:
HYDRAULIC (B. & O. PAT.) OPERATING
REMOTE CONTROL
HYDRAULIC DESCALING
ROSS AIR SHUT-OFF VALVES
HOVALCO BLOW-OFF VALVES

# CRACKS
## lastingly sealed with SMOOTH-ON No. 1




**Smooth-On No. 1 tamped into a crack expands in hardening and forms a permanently pressure-tight seal. The repair is quickly made without heat or special tools, and requires no previous experience.**

**With a can of Smooth-On No. 1, you will be prepared to stop leaks in boilers, tanks, heaters, pump shells, pipe lines, etc., make joints and seams tight, and tighten loose bolts, rivets, fixtures and equipment parts.**

**Buy Smooth-On in 7-oz., 1-lb., 5-lb. cans or 25-lb., 100-lb. kegs from your supply house or if necessary, from us. For your protection, insist on Smooth-On—used by engineers since 1895.**

**FREE**

**Dozens of time-saving, labor-saving and money-saving applications of this many purpose repair cement are described in the 40-page Smooth-On Handbook, which contains 170 diagrams showing ingenious, practical repairs to equipment all over the plant. To receive your free copy, fill in and mail the coupon.**

**Smooth-On Mfg. Co., Dept. 30**
**570 Communipaw Ave., Jersey City, N. J.**

Please send SMOOTH-ON HANDBOOK.

Name .....

Address .....

.....

9-40 .....

*Do it with*
**SMOOTH-ON**


ditions the heat would decompose many oils, forming fatty acids, which, aside from being different in lubricating powers from the original lubricant, tended to corrode the cylinder and piston.

My idea was to use the friction generated in practice as a measure of the oil's anti-friction qualities. Measuring cylinder-and-piston friction was an everyday process for any professional engineer or other competent person owning a steam-engine indicator that he could use under known and controllable conditions of engine speed and steam pressure and temperature.

Having at my disposal the 4 x 12-in. Roberts engine with which I had established, at a Franklin Institute meeting, a record of both load and friction indication at 1120 rpm, I attached this and took friction cards, using pure lard oil for a full day's run. Then swabbing out the cylinder with strong soda-water, I tried a locomotive cylinder oil used on the P & R RR. I took more friction cards and, after a full days run, swabbed out the engine and took cards with the original lard oil to see that conditions had not changed. This test proved the correctness of the idea.

This scheme came to the attention of an oil-refining company and they sent me 5 samples for test (marked *A, B, C, D, E*). Having tried them out, I submitted my report—and bill. Upon which I got a rather strongly worded letter, telling me that either I did not know my business or my testing facilities were defective, or both. Furthermore they refused to pay my bill—all because my report showed their $0.80 oil to be much better than that selling at $1.00.

Being much younger then than I am now, and consequently less diplomatic, I concocted a strongly-worded reply, stating that the alphabet meant nothing to me and that if they would send me similar samples differently lettered I would test them, and if the second set of tests matched the first I should receive not only pay for all the tests but an apology. I got both and also the pleasing statement that the company was highly satisfied to learn that the $0.80-oil was superior, as they made much more of it.

As a result, I got many more such tests, until my engine was put out of business as far as lubricants went, by my testing flake graphite in it. The darned plumbago got imbedded in the pores of the cylinder walls and refused to be dislodged by soda. Later the oil company got its own engine and did its own testing, but not until I had tested cylinder oils for practically every refinery in the country.

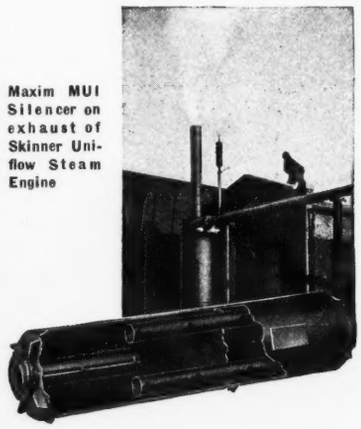
*Leonia, N. J.* ROBERT GRIMSHAW

## Unshackle Arc Welding and Speed Progress

IT IS ALTOGETHER absurd that a valuable and straight-forward industrial process such as arc welding, which has already created tremendous industrial and social benefits, and which will create still greater advances in the future, should be held back by restrictions and regulations which contribute nothing constructive but only serve to impede progress.

The worst feature of all restrictions is


# MAXIM
## SILENCERS



Maxim MUI Silencer on exhaust of Skinner Uniflow Steam Engine

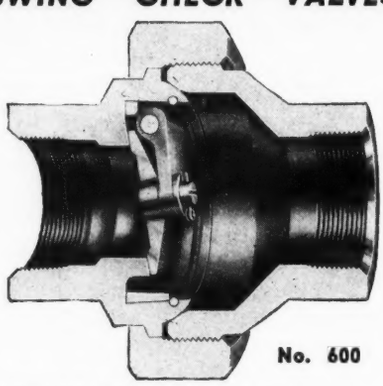
**for STEAM EXHAUSTS**

**MAXIMS provide effective silencing for high or low pressure steam discharges —for internal combustion engine exhaust or intakes, for air compressor intakes and for blowers.**

**If you have a silencing problem, consult MAXIM.**

**THE MAXIM SILENCER CO.**
92 Homestead Ave. Hartford, Conn.

# CATAWISSA
## SWING CHECK VALVES



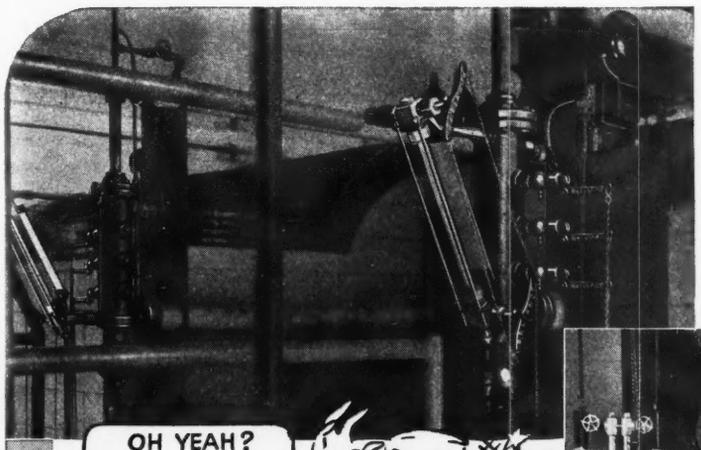
No. 600

**Will Outlast Your Boilers**

**This new valve is practically indestructible. Every part made of steel. Both ends and nut made of forged steel. The seat in the male end is an integral part of the body formed from the solid steel. All inside working parts are made from stainless steel. Designed to give a greater unobstructed flow—opening the Union Nut opens the line, eliminating additional union and nipple. Made in 2" size only.**

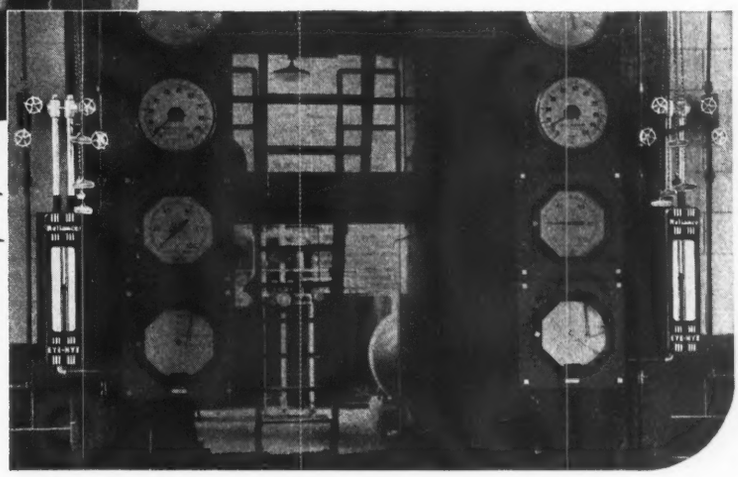
**Will replace any 350-lb. check valve, union and nipple in your boiler feed line—at less cost—will "outlast your boiler." Write for details and prices.**

**THE CENTRAL FORGING CO.**
**CATAWISSA, PENNA.**



*Two No. 5 Reliance Electric Alarms on the air conditioning boilers at the Walt Disney Studio, Burbank, California.*

*As conveniently placed as other panel instruments, the two E-12 EYE-HYEs supply eye-level reading for the water levels.*



©1940 WALT DISNEY PRODUCTIONS

# How the Reliance Safety Team brings Safe, Time-Saving Water Level Supervision in the new *Walt Disney Studio* power plant

With increasing popularity in engineering circles, the Reliance ALARM and EYE-HYE *Sound and Sight Checks* are installed in power plants new and old, large and small. They bring you multiplied safety from water level accidents, and profitable operating efficiency—both of which have definite dollars and cents value to your company.

Here in the new Walt Disney Studios at Burbank, California, the Reliance Safety Team joins the array of modern equipment. Reliance ALARMS—sturdily built, sensitive, dependable—operate large electric bells to warn against unsafe low or high water levels.

Reliance EYE-HYEs take their place on the panel board, bring convenient water gage reading to eye level. EYE-HYE gives a sharp visual indication, assures frequent readings. Easy to install, always accurate.

Insure your plant smoother power control and safe continuous boiler operation, as hundreds of plants now enjoy with the Reliance Safety Team. Write today for illustrated bulletins, Group 94.

**The Reliance Gauge Column Company**
**5902 Carnegie Avenue** **Cleveland, Ohio**

**BOILER SAFETY DEVICES since 1884**

# Reliance

*Why* be satisfied with "just-as-good" welding fittings? WeldELLS alone offer you all these 8 aids to faster, easier pipe welding.

1 SEAMLESS
2 UNIFORMLY FULL PIPE THICKNESS
3 ENGINEERED FOR UNIFORM STRENGTH
4 TANGENTS
5 MACHINE TOOL BEVELLED
6 ENDS MARKED IN QUARTERS
7 COMPLETE IDENTIFYING MARKS ON EVERY FITTING
8 A FULL LINE

TAYLOR FORGE

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Seamless Pipe Fittings for Welding

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General Offices and Works: Chicago, P. O. Box 485

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Philadelphia Office: Broad Street Station Bldg.

that the public many times questions the reliability of welding. As Mr J F Lincoln, president of the Lincoln Electric Co, pointed out in a recent article, there is no mystery in welding. The properly trained and capable welder will consistently make welds stronger than the steel, just as properly trained and able machinists will consistently turn out work machined to the closest tolerances.

Does someone stand over the trained mechanic checking every nut he turns down to make a bolted connection?

Is the trained riveter beset by checkers and inspectors on every rivet he drives?

Is the trained machinist harassed by supervisors on every operation of his lathe?

Are all these trained craftsmen required to pass a test at frequent intervals to qualify for work which they have been doing for years and for which their experience and ability make them fully capable?

Is every single-riveted and bolted connection individually examined, inspected and tested?

Obviously, the answer to all of these questions is "No!".

Yet the present trend in regard to arc welding is in that direction. So many codes, tests, inspections, provisions, restrictions, regulations, etc, are being imposed upon the process that the benefits it inherently creates are being seriously affected. Arc welders are severely handicapped, not only by frequent interruptions to permit inspection of work in process but also by having to be qualified over and over again for a type of work for which they have previously been fully accredited.

There is no more justification for this state of affairs in welding than in any other craft or trade. In fact, there is far less justification. Good welders will consistently make good welds, exceeding the physical properties of the metal welded, and they assure the quality of the weld *by observing the inside of the joint as it is being made* which is not possible with other less-supervised and less-controlled methods of construction.

All these restrictions are due simply to the misplacing of the emphasis and to misunderstanding of the basic principle of arc welding. The uninitiated automatically focus all their attention on the arc welded joint as the crux of the problem just as though the properly welded joint could accomplish any more than make a strong connection, fully as strong as the metal connected. As a matter of fact a good weld—and good welds are consistently made by good welders—develops the full strength of the steel welded. This being the case, why look to the weld for problems that never exist in reality? Why should every weld be individually inspected and tested when the welder who made it is fully as competent in his work as the riveter or bolter is in his? And why, above all, should an experienced welder be required to pass test after test to qualify for work he has been tested for previously?

All of these hindrances are poor practice and highly unfair to welders. Given proper electrodes and proper equipment, the experienced welder will invariably make good

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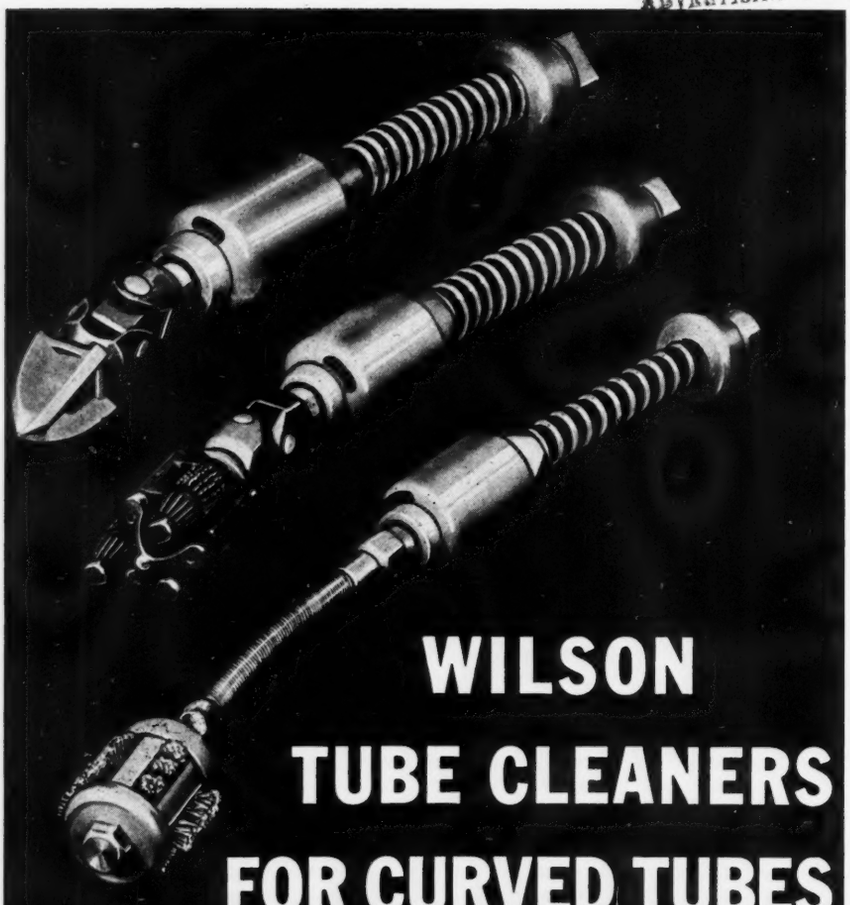

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welds. He knows that his production of sound welds will enable his employer to advance through pronounced improvements and economies in operations. He knows, also, that the benefits which arc welding creates stimulate expansion of his own industry, and by doing so broaden his opportunities for employment and assure his continued earnings. The good welder is a capable conscientious worker upon whom all of the inspection and qualification tests serve only to work hardship. He wants these restrictions removed in order that he may be free to do his work properly and in order that the way may be cleared for further development and expansion of his industry.

As long as these pointless restrictions, regulations, etc, remain, progress with arc welding will be retarded and the immeasurable benefits that it can and will create for industry and society in general will remain unattained.

*Cleveland, Ohio* C M TAYLOR
*The Lincoln Electric Co*

## Straight Method of Socketing Wire Rope

I READ WITH INTEREST the recent articles in POWER on wire-rope socketing and from my experience I recommend the straight method, described in the August, 1939, issue, as being the safest.

Doubling back the strands to form a wedge-shaped mass in the socket became common practice a good many years ago. Used in conjunction with an iron wedge driven into the center of the mass made it a fairly safe job, in view of the fact that a visual inspection of the wires in the socket could be made. When babbitt is poured into the closely bunched mass of doubled-back strands, contact between the babbitt and rope mass may be poor, and, at best, only the outer surface of the outside strand wires makes contact with the babbitt. This is illustrated by photograph 2, page 111, November, 1939, POWER.

I have had much experience with ropes up to 2 in. in diameter, and have seen ropes, socketed by doubling back and babbitting, break where the strands were doubled back. The ropes pulled out of the socket, leaving the doubled part of the strand and the babbitt behind.

Using the combination of doubled-back strands and babbitt would seem to be an attempt to gain the advantages of both the old wedging method and the more modern use of spelter. I believe, however, that this combination results in a job inferior to the straight wire and spelter method. This latter method is always used when pieces of rope are tested to destruction in laboratories and the test pieces always break outside the socket.

*Victoria, B. C.* JAMES DICKSON
*Chief Inspector of Mines*

PROF CHARLES W BERRY of the Mechanical Engineering Dept, Mass. Institute of Technology, noted authority on internal-combustion engines, heat engineering and refrigeration, became professor emeritus in June. He has been connected with the Institute since 1899.

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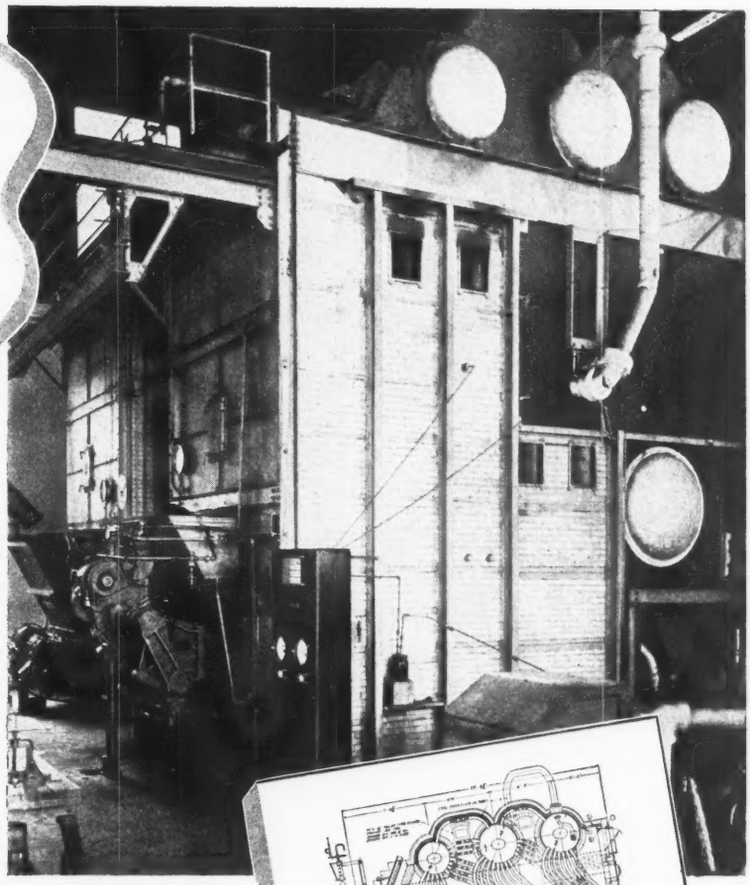

THIS modernly equipped plant, served by two Vogt, four-drum, bent tube boilers, provides dependable, low-cost service the year around for the city of Richland Center, Wisconsin.

A comparison was recently made of the 1939 power output with that of 1935, when boilers of another type, now replaced by the Vogt units, were in service. Plant records revealed that in 1939 a total of 230 tons LESS coal were burned while 2,188,160 MORE K.W. hours were generated than in 1935; a *decrease* in coal consumption and a power *increase* of 88 per cent!

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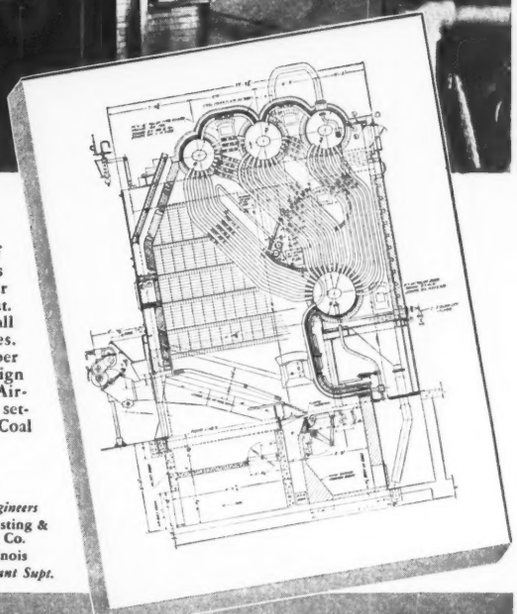

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# Engineers' Books

*(Continued from page 134)*

electric energy in the United States, installed capacity of generating plants, scheduled additions to generating capacity, consumption of fuel by electric generating plants, movement of electric energy across state lines and international boundaries, and per capita statistics relating to the production of electric energy and the capacity of electric generating plants. Supplement (No. FPC S-7) contains detailed tables for each month of 1939 showing production of electric energy by class of ownership, type of prime mover, and by states, together with monthly fuel consumption figures.

AMERICAN STANDARDS AND PROPOSED RECOMMENDED PRACTICES FOR TRANSFORMERS, REGULATORS, AND REACTORS—*Published by American Standards Assn, 29 W 39th St, New York, N. Y. Compiled by a committee composed of representatives from American Institute of Electrical Engineers, the National Electrical Manufacturers Assn, the Edison Electric Institute, Association of American Railroads, and the National Bureau of Standards.*—New proposed standards combine in single volume complete information on rating and behavior of induction apparatus. Section one deals with standards for transformers, regulators and reactors; Section 2 contains test code for transformers, regulators and reactors; and Section 3 is a guide for the operation of transformers. It contains material gathered from numerous sources, among them the standards of the American Institute of Electrical Engineers and the National Electrical Manufacturers Association.

LEFAX DATA. *Recent Lefax Data received from Lefax, Inc, Philadelphia, Pa. includes:* No. 40-8 "Refractories"; No. 40-6 "Arc Welding Practice"; and No. 12-476, "Reinforced Gypsum for Floors and Roofs."

WHY ANTI-FRICTION BEARINGS. *Published by New Departure Div, General Motors Sales Corp, Bristol, Conn. Available on request.*—Of interest to engineers and others desiring to know factors affecting efficiency and performance of machine through use of anti-friction bearings. This book is fairly exhaustive, well-illustrated, discussion of factors to be considered in selection of anti-friction bearings.

THE MYSTERY OF BOILER EXPLOSIONS. *By R C Sermon, Boiler Inspector, 5911 Elinor St, Duluth, Minn. 16 pages, paper bound, price $0.25.*

Aiming to take the mystery out of boiler explosions, the author sets down some hardheaded observations which tend to upset long-held but inaccurate ideas. He particularly takes issue with the tendency to blame most explosions on low water and with the fallacy that admitting cold water to a boiler with overheated sheets or plates will cause an explosion. Any engineer responsible for operation of steam boilers will find this pamphlet interesting and thought-provoking.


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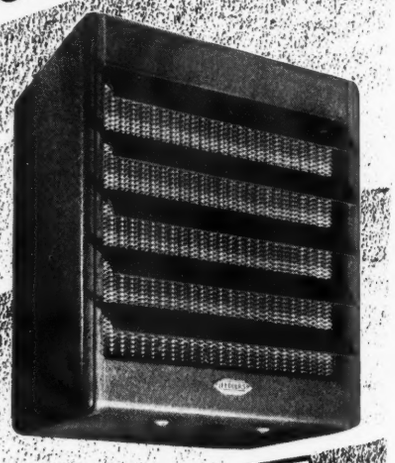

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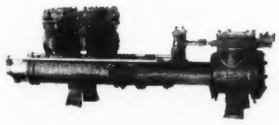

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REFRIGERATION MAINTENANCE CHART. *Published by Mathieson Alkali Works, 60 East 42nd St, New York, N. Y., under direction of R B Engrg Corp, New York, N. Y. Available on request.*—Designed to serve as a guide to the maintenance of refrigerating equipment, chart covers both horizontal and vertical single-acting machines, as well as the associated units, such as different types of evaporators, condensers, etc. Of use to the practical engineer in helping keep machines in good condition and get better efficiency and lower operating costs.

ENGINEERING FOUNDATION REPORT. *Published by Engineering Foundation, Engineering Societies Bldg, 29 W 39th St, New York, N. Y. No price listed.*—Covering 25 years of service, booklet presents information on the formation of the Foundation, the Founder Societies, and data concerning the various projects which the group has initiated.

## Engineering English

HANDBOOK OF ENGLISH IN ENGINEERING USAGE (Second Edition, 1939). *By A C Howell, Professor of English, University of North Carolina. Published by John Wiley & Sons, Inc, 440 Fourth Ave, New York, N. Y. 433 pages, 5 x 7½ in., cloth binding. Price $2.50.*

The key to the content is indicated by the first sentence in the preface: "It is time to face squarely the fact that for the majority of engineers English is primarily a tool for advancement in their profession".

The book is written to serve as a guide for the engineer who wishes to make his English clear, accurate and concise. Chapters cover the following subjects: Characteristics of Engineering Writing, The Word, The Sentence, The Paragraph, The Whole Composition, Punctuation and Mechanics, Grammar, The Business Letter, Reports, Technical Magazine Articles.

The book is detailed and practical, with numerous examples of good and bad ways to say things.

## Diesels

DIESEL MONITOR (1940). *By Julius Rosbloom. Published by Diesel Engineering Institute, Jersey City, N. J. 528 pages, 5 x 7½ in., illustrations, tables. Price $5.00.*

The basic idea of this book—to provide practical information on diesel operation in the form of questions and answers—is excellent. Unfortunately, the author falls short of his goal in several major respects.

Ungrammatical expression can be forgiven when the writer succeeds in explaining himself clearly, but there is no excuse for bad grammar which leads only to confusion. The latter is too often the case in the "Diesel Monitor," particularly when the author departs from practical operating points to discuss theory. Although the material in the first half of the book is reasonably well organized, the latter half appears as a hodge-podge of typical examination questions from various sources and on subjects as widely separated as aero-

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nautics and whistle signals for power boats.

Much worthwhile practical information lies hidden in this book but it is questionable whether the benefits gained would repay the labor involved in digging it out.

## Welding

LESSONS IN ARC WELDING. *Published by The Lincoln Electric Co, Cleveland, Ohio. 144 pages, 6 x 9 in.; over 100 illustrations, including photos and drawings; bound in semi-flexible simulated leather, gold embossed. Price is 50 cents per copy, postage prepaid anywhere in U.S.A. Elsewhere 75 cents.*

This very practical book may be rated an essential for beginners and a very handy reference for experienced welders who wish to check their technique against tested standards. It is a series of 51 lessons based on experiences of Arthur Madson, Instructor of The Lincoln Arc Welding School.

Subjects covered include use of both unshielded and shielded arc electrodes, the adjustment and operation of the arc welding machine and all auxiliary equipment, the making of a great variety of joints, etc.

While the book stresses the use of mild steel electrodes, 15 lessons are devoted to particular joints and metals, and 8 lessons to hard-facing.

## Water Supply

PUBLIC WATER SUPPLIES (4th Edition, 1940). *By F E Turneaure, Emeritus Dean of the College of Engineering, H L Russell, Director of Alumni Research Foundation, and M Starr Nichols, Professor of Sanitary Chemistry, all of University of Wisconsin. Published by John Wiley & Sons, Inc, 440 4th Ave, New York, N. Y. 704 pages; 6 x 9 in.; 232 illustrations; 52 tables; cloth binding. Price $6.00.*

Providing a public water supply was one of the earliest problems that civilized man had to face. In its solution the ancients dug great wells and built massive aqueducts that would do credit to modern engineering practice. The importance of this problem has increased with the years and today practically every engineer has to deal with it in some manner. In this well-known book the authors have dealt with every phase of water-supply problems in a comprehensive and easily understood way.

After an introduction giving a historic sketch of water-supply systems from the ancients down to the present, the work is divided into two parts. Part I deals with quantity of water required and the source of supply, including the prevention of disease transmission in drinking water and laboratory examination of water and interpretation of results. Part II, devoted to waterworks construction, covers hydraulics, wells, river and lake intakes, dams, reservoirs, purification processes, pipe lines and conduits, pumping machinery, distribution systems, operation and maintenance. This new edition has been


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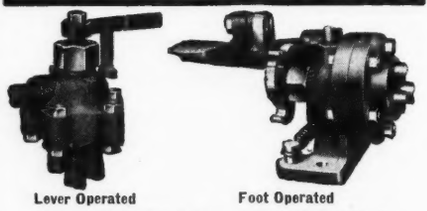

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Fig. 1635

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Fig. 32

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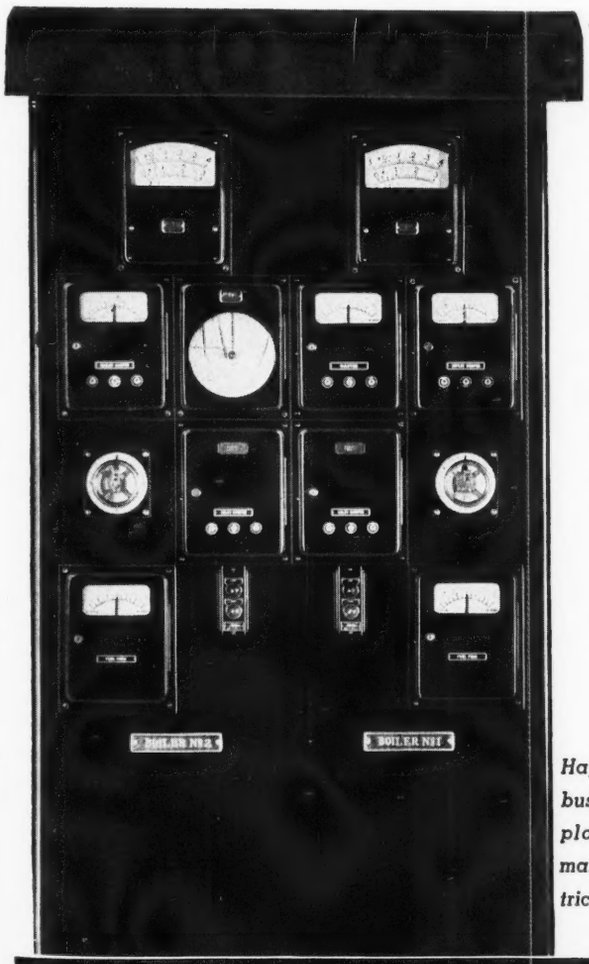


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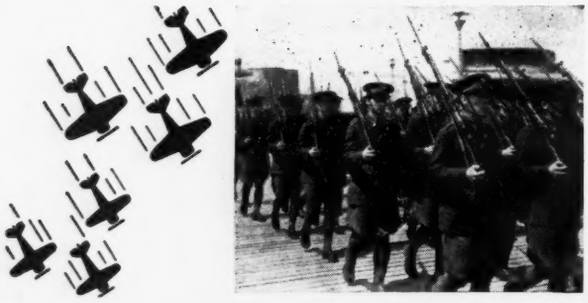

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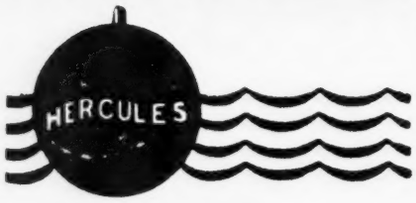


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Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

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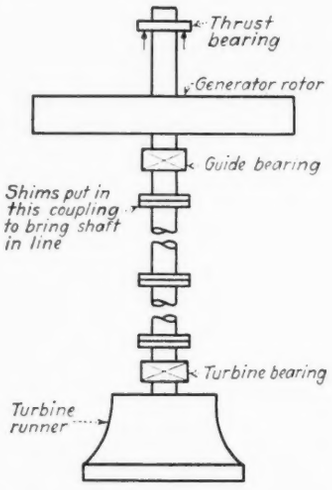
revised to conform to development of engineering theory and practice. The original comprehensive character of the book has been retained to make it of value to students and young engineers in all phases of waterworks engineering as well as to experienced engineers.

PHYSICAL SPECIFICATION CHART. *Published by Meehanite Research Institute, Pittsburgh, Pa.*—Wheel chart, free on request, quickly reveals physical properties of general engineering castings, as well as heat, corrosion, and wear-resisting types.

## Alignment Cures Bearing Trouble

AN 1875-kva vertical hydroelectric unit with a long shaft between generator and waterwheel gave a lot of trouble from worn and burned-out bearings and other faults. One day one of the gates broke, fell into the runner and put the machine out of business. When the new parts were being installed, the plant engineers made a complete check of the machine's alignment.

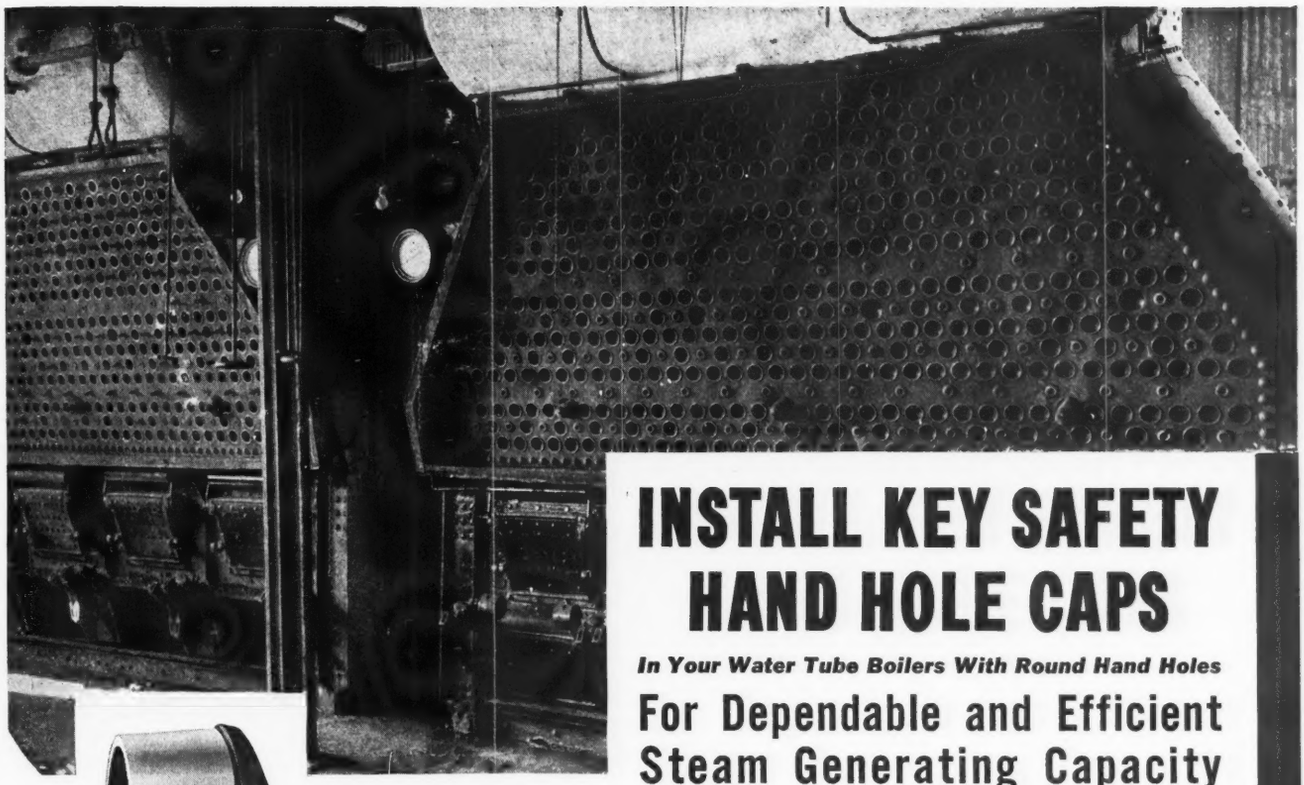
First, they leveled the generator rotor and placed its shaft center vertically over the center of the waterwheel curb ring. The rotor was then turned through




one half revolution, alignment measurement again taken and adjustment made.

The generator coupling flange was found burred on one side as if the rotor had been dropped. This was corrected and the first section of shaft bolted into place. When this was done the lower end of the shaft was found to swing $\frac{3}{8}$ in. out of line. We shimmed the coupling to correct this, then added the next section of shaft and the runner which came into true alignment. This may have been a crude way of doing the job but it eliminated all of our previous troubles with the unit.

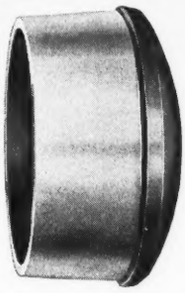
*Kearney, Neb.* ED SWAN



# INSTALL KEY SAFETY HAND HOLE CAPS

***In Your Water Tube Boilers With Round Hand Holes***

## For Dependable and Efficient Steam Generating Capacity



## Eliminate Gaskets...Prevent Leaks...Prevent Corrosion...Save Downtime...Save Constant Renewals . . . Save Fuel – Easily Insulated

*Now Is The Time* to analyze your peak steam generating requirements. Can you increase your steam generating capacity as fast as your factory will want to increase its steam using capacity? Will you require the use of stand-by equipment to meet peak load operation? If so, you cannot rely on low load periods, nights or weeks, to clean and repair boilers. You must reduce downtime to a minimum. Key Safety Hand Hole Caps will enable you to do this . . . put your water tube boilers in tip-top condition for maximum and dependable steam generating capacity.

**INSULATION**—Key Caps permit easy insulation of headers providing savings in fuel that will help pay for the Key installation in a minimum of time.

### KEY SAFETY HAND HOLE CAPS

. . . provide a one-piece closure for round hand holes in water tube boilers as against the old style 5 piece closures. Key Caps have been in actual operation for over 20 years and have proved their worth with the result that many millions of them are in every day service.

They eliminate the use of nuts, crabs, bolts and gaskets, and make the heading-up of a boiler as simple as putting a cork in a bottle. No gaskets are required and since their co-efficient of expansion is equal to that of a header, there is no leakage at any time. Boilers equipped with Key Caps can be stripped for cleaning and headed up again in about 1/10 the time required for old style 5 piece closures. Labor time and downtime are drastically reduced.

### INSTALLATION SERVICE

All original installations of Key Caps, either in new or old boilers, are made by skilled Key mechanics—thoroughly trained to do the job. You do not purchase expensive installation equipment—our service department provides all working equipment and insures you of a correct installation in every case.

### WRITE FOR THIS BOOK TODAY

***For Complete Details of the Key Safety Hand Hole Cap Installation***

Bulletin No. 94A—a 16 page book will give you the complete details of the Key Safety Hand Hole Cap Installation for your water tube boiler with round hand holes. Write for this book today *plus* a list of Key Cap installations which shows the hundreds of outstanding concerns who have benefited through the use of Key Caps. Ask for Bulletin 94A.

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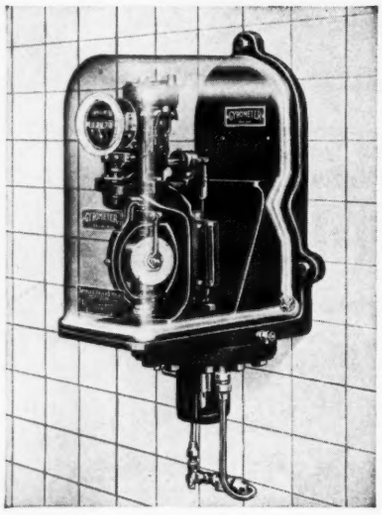

When totalizations of boiler feed, condensate, steam and air must be accurately determined specify the GYROMETER.

Designed for use with orifices, nozzles or venturis, the GYROMETER provides an accurate and dependable summary of your flows.

*Write for Data*

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6780 Upland Street
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# PRACTICAL AIDS TO OPERATION

## Changes in Pipeline Cure Water Hammer

OUR VACUUM-RETURN PUMPS are in a small basement in front of the main factory building, over 800 ft from the power plant. The 3-in. return line from these pumps runs up from the basement nearly to the ceiling and then makes a 700-ft level run to the rear of the factory. Here it turns at righ angles with two elbows and a close nipple giving a 10-in. rise to line level. After a 50-ft run in the new direction, another right-angle turn gives another 10-in. rise to the line. From this point the line continues level to the power house, where it drops 20 ft to the basement.

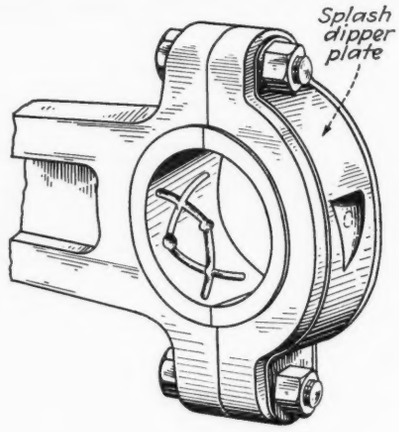
A severe water hammer developed in this line. Throttling the pump discharge helped some, but at times the hammer was so severe that leaks developed at the joints. After everything else had been tried to cure the trouble, we reversed the two 10-in. rises in the line to give a 10-in. drop at each turn and as far as possible lowered the line to give some fall from the front of the building to the power-house basement. Now the water hammer is so infrequent and so slight when it does occur that there is nothing further to worry about.

*Rochester, N. Y.* H P KING

## Portable Electric Fan To The Rescue

WHEN A MOTOR must be run overloaded for short period, a portable electric fan can be set to blow a cooling stream of air into the windings, thus safely increasing the capacity. The same idea can be used to cool bearings that are temporarily running hot. In either case, the real answer lies in an equipment change to cure the overheating problem permanently.

*Boston, Mass.* L W ROGERS



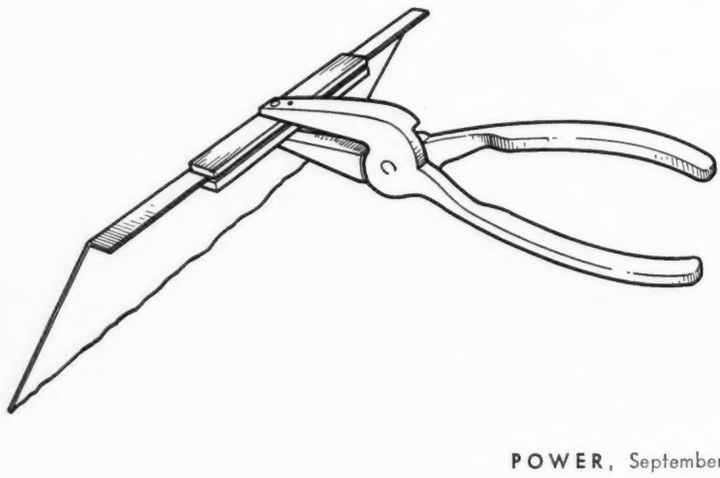

## Splash-Dipper Cures Bearing Trouble

ON ONE OF OUR PUMPING ENGINES we had difficulty in properly lubricating the crankshaft connecting-rod bearings. These bearings were splash-lubricated but they apparently did not get sufficient oil.

We solved this problem by putting an oil dipper and pocket on each bearing, see drawing. This consists of a forged-steel U with a triangular hole in its center. Around the hole we welded a semi-circular pocket to dip and hold the oil at a hole into the bearing oil grooves. The dipper is held tightly in place around the bearing cap by the cap bolts.

*Penacook, N. H.* C H WILLEY

## Wide-Gripping Pliers

THE DIAGRAM shows how to convert an old pair of pliers into a wide gripping tool for bending the edge of thin sheet metal. They can also be used for breaking strips of glass. The gripping edges are made of two $\frac{1}{2} \times \frac{3}{16} \times 1\frac{1}{2}$-in. flat steel strips riveted to the plier jaws.

*Boston, Mass.* L W ROGERS